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SIAM

NATURE AND INDUSTRY

Issued
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The Ministry of Commerce
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Bangkok
1930

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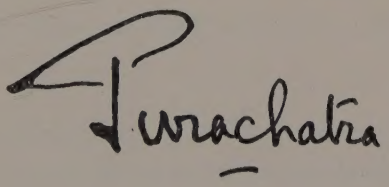
FOREWORD

For the ordinary tourist there is much to be learnt by personal visits to strange countries about the manners and habits of the people as well as the produce of a country, besides merely seeing the sights of that country. There is, however, a growing class of tourists with an enquiring turn of mind who wish to learn more about the economic problems and products of the country they pass through. For this class of tourists information on economic matters is difficult to gather on a short visit, and very often they have to be burdened with quite a large number of books in order to cull from them the particular information required.

In editing this volume of monographs, the aim has been to put together before the public, in a concise manner, some of the more important data available about the economic life and products of the Kingdom of Siam. It is hoped that this book will fulfil the requirements of those who really wish to study the status and situation of Siam on the production side.



Minister of Commerce and Communications,

Bangkok, August 1930.

Introductory Note

A series of fourteen pamphlets, describing various aspects and activities of Siam, was issued in 1926. These pamphlets had a considerable sale and, as the issues was nearly exhausted, it was decided to bring them up to date, and re-issue them as one volume, to be published in time for the Eighth Congress of the Far Eastern Association of Tropical Medicine, to be held in Bangkok in December 1930.

The Executive Committee of the Congress had, at the same time, determined to issue a volume in celebration of the visit of the Far Eastern Association of Tropical Medicine; this volume to include various subjects not treated in the original pamphlets.

In order to keep the two volumes distinct in character, and to avoid overlapping, it was agreed that the Executive Committee should take over certain of the original pamphlets for inclusion in their volume; while some new articles were added to the present book, which, as now constituted, is chiefly concerned with the natural features, industry and commerce of Siam. The character of the original articles has been preserved as much as possible, though this involves some repetition.

Each of the original pamphlets had a specially designed cover, part of which has been used in some of the present chapter headings.

At the end of the volume will be found a note giving the names of the various authors who have been concerned in preparing this book.

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CHAPTER I

PHYSICAL FEATURES

Before commencing a description of the physical features of Siam, it should be pointed out that the Siamese names in this article are transliterated according to the phonetic system explained on the accompanying map; the system is designed on the lines recommended by the Royal Geographical Society of Great Britain.*

Siam lies between the parallels of 5° and 21° North Latitude, and between the meridians of 97° and 106° East Longitude. The area of Siam is about the same as that of France, and is 518,000 square kilometres, or 200,000 square miles. Its greatest length is 1650 kilometres and its greatest breadth 800 kilometres.

The surface of the country is characterized (1) by flat alluvial plains, which become inundated during each rainy season and which are intersected by winding rivers and streams; and (2) by mountains covered with forest. There is also a certain amount of undulating country.

For convenience of description Siam may be divided into four parts, Northern Siam, Central Siam, Eastern Siam and Southern or Peninsular Siam. Peninsular Siam is bounded on

*This system has not been followed by the writers of other articles in this book.—Ed.

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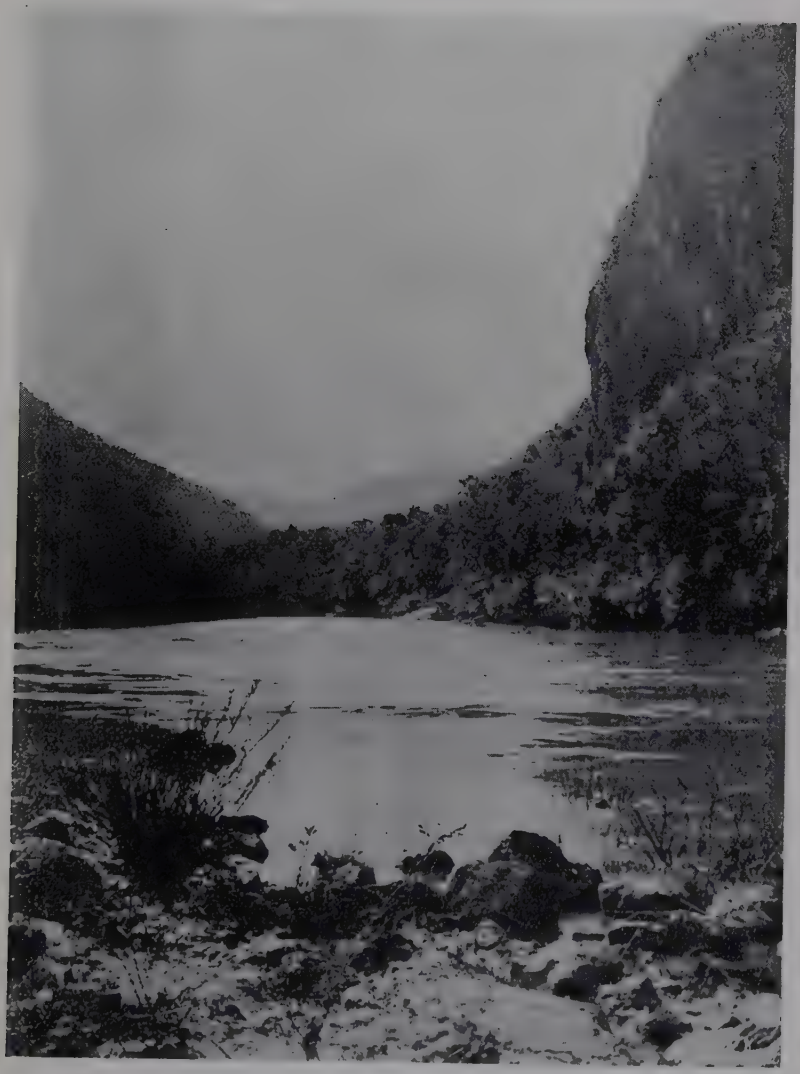
the west partly by the Indian Ocean and partly by Burma, on the east by the South China Sea and the Gulf of Siam and on the south by the British Malay States of Perlis, Kedah, Perak and Kelantan. The rest of Siam has for its northern neighbours Burma and French Laos, for its western neighbour, Burma, for its eastern neighbours, French Laos and French Cambodia and on the south it is bounded by the Gulf of Siam and Southern or Peninsular Siam.

Northern Siam

The three great rivers, the Salwin (known to the Siamese as the Mênam K'ŏng), the Mekong (known to the Siamese as the Mênam Mêk'ông) and the Yangtze Kiang rise in the Kwenlun in Tibet and flow parallel to one another in a direction due south for a distance of more than 400 kilometres between the Latitudes of 32° and 27° North. For most of this distance their beds, which are separated by precipitous ridges, are not more than 30 kilometres apart. The Yangtze parts company from the other two at Latitude 27°, turning abruptly east, to meander a further 2500 kilometres through China before it reaches the China Sea; the Salwin continues to flow south with a westward drift until it reaches the Indian Ocean at Moulmein in the Latitude of 16°, and the Mekong takes a sharp turn to the east in the Latitude of 20° to make room for Siam on the map, and eventually bending southwards flows into the South China Sea at Saigon in Latitude 10° North.

At the point where the Salwin and Mekong part company the main ridge of mountains between them becomes part of the northern frontier of Siam. This ridge, known as the Dên Lāô, breaks into a number of parallel ridges with a general strike to the N. N. E; the western one, known as the T'anŏn Tŏng Chai continues southward, under different names, to form the backbone of the Malay Peninsula; the next ridge to the east is the K'un Tān Range, to the eastward of which again are the P'ī Pan Nam Mountains and the Lūong P'rabāng Range. The latter stretches into the loop of the Mekong and forms a part of the north-eastern frontier. Between these ranges are the valleys of four of the



View in the Mê Ping Rapids.

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rivers which finally unite their waters in the Mênam Chau P'ayā (the Mother-of-waters-in-chief), the principal river of the kingdom. The names of these four rivers are:—the Mê Ping rising in the Dên Lāô Range, the Mê Wang, the Mê Yŏm and the Mênam Nān.*

The northern part of Siam containing these rivers is a mass of mountains, but here and there along the larger streams are level stretches; as for example, at Chiengmai on the Mê Ping, at Nak'on Lampāng on the Mênam Wang and at Müong Nān on the Mênam Nān. At these points there are considerable areas of flat alluvial ground suitable for the cultivation of rice and on that account these valleys have become comparatively thickly populated. Along these rivers and their tributaries other such level stretches are to be found, but for the most part the rivers cleave their way between precipitous banks, and rapids are of frequent occurrence. To the north of the P'ī Pan Nam Mountains there are wide, level, and often swampy, districts drained by the Mênam Ing and the Mênam Kok, both of which flow into the river Mekong. At times when a rapid rise occurs in the waters of the Mekong there is a reverse current in the Mênam Ing for a distance of 30 kilometres upstream.

At about Latitude 18° the hills recede from the four rivers that go to form the Mênam Chau P'ayā, leaving wide areas of level and swampy ground, which gradually merge into the great central plain.

On the west, the River Salwin, flowing swiftly through a narrow trough in the hills, forms, with its tributary the Mê Mēue, the frontier between Siam and Burma for upwards of 300 kilometres.

The average height of the peaks in this northern area is 1600 metres above mean sea level. The ground level in the City of Chiengmai is 300 metres, and at Chiengrai 378 metres. Doī Āngkā (Doi Intanon), 2576 metres, the highest mountain within the boundaries of Siam, is situated about 50 kilometres to the

*In Siam a river is correctly known as Mênam, but this is often abbreviated into Mê or Nam.

south-west of Chiengmai; Doi Sut'ēp, 1676 m., overlooks Chiengmai from the west; Doī Chīengdāô, 2185 m., lies north of Chiengmai and Doī Pā Chô, 2012 m., to the north-east. These are the principal and best known peaks.

Central Siam

Central Siam may be divided into three parts, (1) the area south of Latitude 18°, drained by the Mênam Chau P'ayā, the Mênam Sup'an and the Mênam Bāngpakŏng, (2) the area drained by the Mêklōng and (3) the area south of the Chant'aburī Mountains.

The Mênam Chau Payā* is the principal physical feature of the country. Not only is it the principal channel of communication, transporting two of its chief products, teak logs in rafts and rice in great river boats, but it is also a source of great wealth in that it carries in its waters the valuable silt, which in the rainy season, by inundation, is deposited on the flat rice growing areas of central Siam.

At Pāknamp'ô the waters of the four rivers of the north are finally united in the Mênam Chau P'ayā, and 50 kilometres lower down, near the old town of Chainād, the river bifurcates to form a delta 90 kilometres long. The western branch is said once to have been the principal stream, and truly with all its windings its general direction is remarkably straight. Where it breaks off from the main stream it is known as the Klōng Mak'ām Tau, lower down as the Mênam Sup'an; where it passes under the Southern Railway Line it is known as the Mênam Nak'on Chaisī and at its mouth as the Mênam Tāchin. The practice of giving a river different names at different parts of its course is common in Siam and especially in the central plain, where it obtains even for short canals.

The eastern and principal branch of the Mênam Chau P'ayā divides and reunites at several points, the chief stretches being known as the Menam Nōī or lesser river, the Mênam Yai or great river, the Mênam Lŏpburi, etc. At Ayut'ayā it receives the

* Often written Chao Phya, Chao Bhraya, &c. and known generally as the Menam.

Photo by Royal Aeronautical Service.

River view, Bhisnulōke District.

This shows rice-fields with scattered clumps of trees; a town; a river at low water with extensive sand-banks exposed; a road and, in the top right-hand corner, the railway.

waters of a great eastern tributary, the Mênam Pāsak, which, rising in the P'ĕchabun Mountains, drains the western slopes of the mountains of the Dŏng P'ayā Yĕn Forest. The water of this tributary is now being utilized to irrigate a large part of the lower plain between the Mênam Chau P'ayā and the Mênam Bāngpakŏng. The Mênam Chau P'ayā is tidal as far as Ayut'ayā.

The Mênam Sakêô, known lower down as the Mênam Prāchin, and lower down still as the Mênam Bāngpakŏng, rises near the frontier of Cambodia and drains the basin between the San Kamp'ĕng Range and the Chant'aburī Mountains. It reaches the sea at the north-east corner of the Gulf of Siam.

The Mênam Bāngpakŏng and its tributary the Mênam Nak'on Nāyŏk may be regarded as a part of the delta of the Mênam Chau P'ayā. There is practically no difference of level across the whole plain and the three rivers of the plain are joined up by a net-work of canals or k'lōngs which are used for irrigation, drainage and transport.

The central plain is over 300 kilometres in length and it varies in breadth from 50 to 150 kilometres. At Latitude 18° the banks of the Mê Yŏm are 44 metres above mean sea level, at Pāknamp'ō the banks of the main river are less than 25 metres above mean sea level, near Chainād at the head of the Delta, 18 metres, and at Ayut'ayā not more than 4 metres, whilst in Bangkok City the roads seldom are more than 1.80 metres above mean sea level. This will give some idea of the flatness of the central plain, and its liability to become inundated.

Great quantities of silt are carried down and deposited on the bar at the mouth of the river each year, and the land is gaining steadily along the northern shores of the Gulf. It is a very short time, geologically speaking, since Ayut'ayā was as near to the sea as Bangkok is to day, in evidence of which it may be stated that numerous sand banks containing sea shells of recent date are to be found all over the central plain. These sand banks were at one time sand bars which guarded former mouths of the river.

To the west of the central plain is the watershed of the Mêklōng or Rātburī River. The eastern or main branch of this

river, known as the K'wê Yai, rises at the tail end of the T'anŏn T'ŏng Chai Range in Lat. 16°, where there is a veritable mass of high and most difficult peaks, about 2000 metres in height. At this point the main range breaks into three distinct ridges. At the head of the westernmost of the three is situated the pass of Three Pagodas (P'rachēdī Sām Ōng), and it is here that the K'wê Nōi or lesser branch of the Mêklōng takes its rise. This western range, known as the Tenasserim Range, forms the frontier of Burma and Siam from the Latitude of 16° to the Latitude of 11°. It varies in height from 700 to 1500 metres and is densely forested. To the west of the K'wê Nōi it averages about 1100 metres. The range between the two branches of the river is made up of bare limestone crags reaching a height of 1300 metres.

The two branches of the Mêklōng River join together at the old town of Kānchanaburī, or Kānburī, in Latitude 14°, and the main river enters the sea at the north-west corner of the Gulf. The total length of the K'wê Yai and the Mêklōng together is not less than 400 kilometres. The upper reaches of the river are magnificent and are famous for the beauty of their scenery. The banks are steep and clothed in dense evergreen forest. Rapids and waterfalls abound. Even at Rātburī the banks of the river are as high as 12 metres, and, although the river is broad at that point, serious floods are common.

The only part of Central Siam not yet dealt with is the district between the Chant'aburī Mountains and the Gulf. This area is drained by numerous streams all flowing in a southerly direction, the chief of which are the Mênam Chant'aburī, the Mênam Wēn and the Mênam Trād. The principal peaks in the Chant'aburī Mountains are K'au K'îô, 800 metres high, which is the only mountain visible from Bangkok, K'au Sōi Dāô, 1640 metres, K'au P'rabād, 1078 metres and K'au Sabāp, 933 metres.

The Chant'aburī Plain is flanked on the east by a line of hills called the Bant'at Hills, which lie along the Cambodian frontier, and on the west by the Chant'aburī Mountains, which bend southwards along the coast of the Gulf. The

coast of this part of Siam is much indented and closely fringed with rocky and jungle-clad islands. The island Ko Sī Chang lies near the northeast corner of the Gulf and forms a good natural shelter for large steamers which cannot cross the bar of the Mênam. The largest island on this coast is Ko Chāng, in area about 180 square kilometres, and the next in size are Ko Kūd and Ko K'rām. Ko Chāng is 30 km. long and its greatest breadth is 10 kilometres. Its highest peak reaches 644 metres in height.

Eastern Siam

Eastern Siam consists of a saucer-shaped plateau tilted to the S. E. and a narrow strip of swampy country to the north thereof. It is bounded on the north and east by the River Mekong on the west by the P'ĕchaḃūn Mountains and the massive flat-topped peaks of the Dŏng P'hyā Yĕn, and on the south by the Sankamp'ĕng Range and the Dŏng Rĕk Scarp.

The plateau proper is guarded on the north and east from the Mekong by a line of hills varying in height up to 600 metres, and it is drained entirely by the river system of the Nam Mūn, which escapes through this line of hills at the southeast corner, and empties into the Mekong.

The Nam Mūn rises in the Dŏng P'ayā Yĕn and its course is due east, draining the southern part of the plateau. Its principal tributary, the Nam Chī, also rises in the same mountains and flows in a circular course through the centre of the plateau, joining the Nam Mūn a short way above Ubŏn. The Nam P'au carries off the surplus water from two great freshwater lakes lying to the north of the plateau and empties itself into the Nam Chī.

The western and northern sides of the plateau vary in height at different points from 130 to 200 metres above mean sea level, whilst at Ubŏn the levels are said to be in the neighbourhood of 50 metres.

The plateau is flooded during the wet season and the cart tracks are impassable; in the dry season there is great scarcity of water.

The mountains of the Dŏng P'ayā Yĕn Forest consist of a mass of flat-topped peaks, varying in height from 800 to 1300 metres. The highest peak is K'au Lêm, which attains a height of 1328 metres. Thè Dŏng Rĕk Scarp is in general about 400 metres in height, but in parts it rises to 700 metres. The ground falls off sheer towards the south, whilst the fall to the Nam Mūn northwards is gradual. In like manner the ground on one portion at least, of the northern side of the plateau, falls abruptly towards the north, but accurate geographical information of this area is scanty, as the topographical survey has not yet been carried out.

The strip to the north of the plateau is drained into the Mekong and varies in width from 50 to 100 kilometres. It contains the largest freshwater lake in Siam, the Nōng Lahān, in area about 170 square kilometres; this lake is connected with the River Mekong by a stream called the Nam K'am. The strip is also drained by numerous other streams flowing into the Mekong, but the only one of importance is the Mênam Songk'rām. All these streams, like the Mê Ing, have a reverse current for many kilometres upstream when the Mekong is in flood.

The Mekong (Mênam Mêk'ông) itself, forming the boundary of the kingdom for upwards of 1300 kilometres, is a huge river studded with islands and broken up by many impassable rapids. Along the frontier it is from 700 to 1300 metres in breadth.

Southern or Peninsular Siam

Southern Siam consists of a long peninsula extending from the head of the Gulf, in Latitude 13°, down to British Malaya, in Latitude 5° 30′. On the east its shores are washed by the Gulf of Siam, and the South China Sea. On the west the Tenasserim Range and the Mênam Kra separate it from Burma as far south as 10°, after which it abuts on the Indian Ocean. The southern boundary with the British Malay States is the mountain range known as the Kālāk'īrī.

The breadth of Southern Siam varies from 15 to 200 kilometres and its length is 750 kilometres,

The Tenasserim Range, in the neighbourhood of the P'ĕchaburī and Prān Rivers, is massive and attains to heights of 1000 to 1500 metres, but further south it becomes narrow and is seldom higher than 900 metres. There is, however, one conspicuous peak at Latitude 11½°, called K'au Lūong (Prachuab K'īrīk'an), 1247 metres in height. To the north of this peak is one of the lowest passes across the Burma frontier, the height of which is 237 metres only; it is known as the Jalinga Pass or Chōng Singk'on. The Tenasserim Range is split by the Mênam Kra into two parts, the western being in Burma and the eastern in Siam. The eastern range continues due south to the island of P'ūkĕt, skirting the Indian Ocean, and is known as the P'ūkĕt Range. The main ridge of the Peninsula starts afresh to the north of the City of Nak'on Sītamarāt, the intervening country, between the P'ūkĕt and Nak'on Ranges, being dotted with isolated peaks rising sheer out of the plain. One massive hill in this group, K'au P'anŏm Bĕnchā, attains a height of 1404 metres, but for the most part the peaks are only a few hundred metres high.

The Nak'on Range reaches the south-west corner of Siam, and is continued along the frontier under the name of the Kālāk'īrī, which again spilts into parallel ridges with a north and south strike. The highest peak of the Nak'on Range is K'au Lūong (Nak'on Sītamarāt), a large, round and massive hill, 1786 metres in height, surrounded by jagged peaks, the next highest of which is K'au Mĕn, 1309 metres.

The frontier range on the south varies in height from 400 metres at each end to 1500 metres in the middle.

Besides the above ranges there are many small subsidiary ranges lying parallel to the main ranges, the chief of which is Sām Roī Yōd, or Three Hundred Peaks, an isolated set of bare limestone pinnacles lying to the south of the Prān River and varying in height from 300 to 600 metres.

In the northern part of Peninsular Siam the streams usually flow either in a north or in a south direction behind these subsidiary ranges until they find a passage eastwards to the sea; they

are very numerous but small in size, the largest being the Mênam P'ĕchaburī, the Mênam Prān and the Mênam Bandōn.

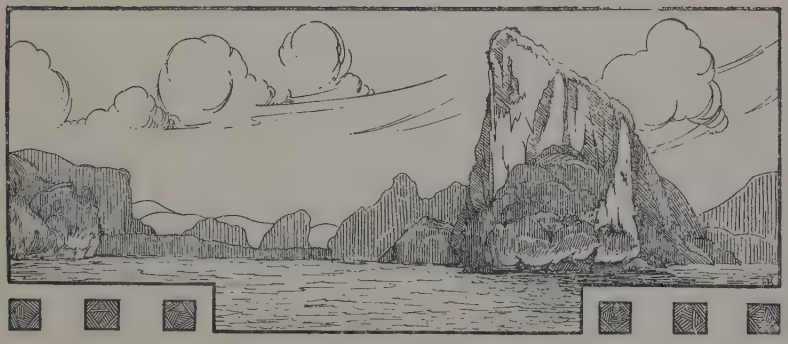
The latter is a short delta and is made up of the waters from two large streams, the Mênam Tapī and the Mênam K'īrīrat which, flowing northward towards the Āô Bandōn, drain a wide plain between the Na'kon and P'ūkĕt Ranges.

There are two other coastal plains of considerable extent to the south; that to the east of the Nak'on Range contains a great brackish lake, the T'alē Sāp, whilst the plain of Pātānī in the southeast corner of Siam is drained by streams from the frontier range, which flow north to the sea; the largest of these streams are the Mênam Tānī or Pātānī and the Mênam Saiburī.

The only important rivers flowing into the Indian Ocean are the Mênam Trang and the Mênam Kra. The latter has a wide estuary, studded with sand banks and islands, and known locally as the Mênam Pākchan.

On the east coast of the Peninsula there are few bays, Āô Sa-wī, Āô Bandōn and Āô Nak'on being the most important. The islands also are few in number, the largest being Ko Samūi and Ko Pa-ngan. These two islands form a continuation northward of the Nak'on Range. The west coast, on the other hand where the mountains extend down to the sea, is much indented with bays and closely fringed with islands. In spite of this there is no harbour or safe roadstead deep enough for ocean liners on the west coast. The most important of the islands is Ko P'ūket, the centre of the tin industry. Its area is about 600 sq. kilometres. Its length is 48 km. and its breadth 20 km.

Amongst the other islands may be mentioned Ko Lantā, Ko P'rat'ōng, Ko Yāô Yai, Ko Libŏng and Pulo Tarutau.



CHAPTER II

GEOLOGY

Our knowledge of the geology of this country is still very imperfect. Several geologists have visited Siam and made more or less hurried journeys through various parts of the country. Some account of their observations have been published by three of these: Mr. B. Hogbom[(1)], Mr. Wallace Lee[(2)], and Dr. W. Credner[(3)].

In compiling the present account most of the information has been derived, often verbatim, from Mr. Lee's reports, but Dr. Credner's paper has also been largely drawn on.

So much of the country is covered with jungle that natural outcrops are rare; in the southern provinces there are, however, some good artificial exposures along the railway and highways. Deep weathering is another of the difficulties the geologist here has to contend with.

---

(1) *B. Hogbom.* Contributions to the Geology and Morphology of Siam. Bull. Geol. Inst. of Upsala, Vol. XII, pp. 65-128. Upsala, 1913.

(2) *W. Lee.* Reconnaisance Geological Report of the Districts of Payap and Maharashtra, Northern Siam. Dept. of State Railways, Bangkok, 1923.

W. Lee. Reconnaisance Geological Report of the Provinces Puket, Surashtradhani, Nakon Sridhamaraj and Patani in Siamese Malaya. Dept. of State Railways, Bangkok, 1923.

(3) *W. Credner.* Problems of Geomorphology in Siam. Journ. Siam Soc., Nat. Hist. Sup., VII, pp. 25-46.

Topography

One of the most impressive morphological features in Siam is the preponderance of wide plains. Among these are those with mighty alluvial deposits, like the Menam Plain; those with only a thin cover of deposits, like the plains in the Peninsula, in the south-east and in the north of the country, and those with nearly no general alluvial cover at all, like the Korat plateau.

The second of the main features is the appearance of mountain ranges all stretching in the same direction, chiefly from N to S., as well in Northern as in Western and Southern Siam, and on the other hand the absence of such ranges in the Korat district, or the eastern part of Siam.

The third impressive feature is the very steep slopes with which the mountains and mountain ranges ascend from the plains.

Sometimes there is, as in Northern Siam, a narrow zone of low foot-hills between the plain and the mountain slopes.

The last important feature is the remnants of plains or flat mountainous country in the higher levels of the Siamese landscape. They are to be found in the mountainous limestone country north of Kanburi, in Northern Siam in the highest parts of the mountain ranges in the extreme north-eastern section of the country, and in the limestone ranges of the north-west, where they are to be seen south-west of Muang Fang in an especially distinct form.

The valleys in many places follow the softer beds between folded hard rocks and vaguely indicate the structural trend. The folding of the rocks has, however, been intense and was accompanied by faulting of considerable magnitude. The course of the streams is modified by these irregularities of structure and in places they flow transversely to the folding.

Stratigraphy

The rocks found in Siam may be divided as follows:—

Igneous Rocks
Metamorphic Rocks

Palaeozoic Rocks
Mesozoic Rocks
Quaternary Deposits

Igneous Rocks

Granite. The most important igneous rock is granite: it outcrops in laccolithic masses intruded into the Palaeozoic sediments and has been exposed by the erosion of the latter.

Though the granite has not been followed continuously for a great distance in any of the ranges, it is inferred that there is a granite core in the main mountain ranges. The great range west of Chiengmai in N. Siam has granite exposures in several places from Doi Pahom Pok on the northern boundary southwards as far as latitude 16° N. Granite, perhaps in the same fold, is known to occur in the border range between Tavoy and Kanburi and again to the hills west of Prachuap.

There is what seems to be a broad and continuous belt of granite commencing east of Muang Fang and continuing, with a rather sinuous course, at least as far as the Kun Tan tunnel, but it is possible that this belt continues much further south and is that which the Me Ping cuts through in about latitude 17°.30′ N.

There are several other smaller outcrops of granite in the north but, as far as known at present, of less importance than the above.

In the Peninsula it seems likely there is a deep seated granite laccolith extending a long distance in a north and south direction, only the upper projections of which are exposed about Puket. Some of the other islands off this coast, like the Sayers, are granite. Granite also outcrops intermittently in a belt east of Trang, extending northwards towards Kao Luang. A large granitic mass outcrops east of Hat Yai and South of Singora. South of the railway line near Na Pradu granite is exposed for a distance of 15 kilometres. It is probable that there are many isolated granite areas between the Hat Yai-Kelantan line and the Kedah border.

On the eastern side of the Gulf granite outcrops in Kao Sabap, a mountain east of Chantabun, and again north of Chanta-

bun, in the range whose culminating point is Kao Soi Dao. Granite has also been reported at the base of the limestone in Kaw Si Chang, only uncovered at low tide, at Kaw Kam and Anghin.

Intrusive rocks. In the north there is a considerable variety of intrusive rocks. A basaltic dike occurs a few kilometres south of Lampang, with which is associated a lava field. The flow is relatively fairly recent, since not much erosion of the sheet seems to have taken place. There are also basic dikes east of the Kun Tan granite belt on the Chiengmai—Chiengrai road, north-east of Nan and east of Chiengdao on the Hui Me Taw. Most of the intrusive rocks in N. Siam are, however, rhyolites or andesites. A very large dike, probably of rhyolite, forms a conspicuous ridge 25 kilometres northeast of Muang Prayao. Other dikes are known in the north, particularly in the Nan and Chiengrai provinces.

The strike of these dikes corresponds in general to the structural trend of the locality, though that of the dike northeast of Muang Prayao seems to be at variance with the structural trend.

In the east of Siam, south of Korat, there is a large area of basalt, extending from Ban Map Kra to Nang Rawng. Kao Panom Rung, a low hill on this area, seems to be entirely basalt.

Basalt is also said to occur in the ruby mine district, along the foot of the boundary hills in the provinces of Chantaburi and Krat.

In the Peninsula the granite, and occasionally the surrounding sedimentary rocks, are intruded by moderately coarse grained granite pegmatite dikes, which are the ultimate source of the tin mines in the peninsula. Most of the tin recovered is from alluvial deposits derived from the decomposition and erosion of these dikes.

Metamorphic Rocks

Practically all the metamorphic rocks occur on the flanks of, or in association with granite intrusions. These rocks consist chiefly of schists, gneiss, slate and quartzite. It is probable that most of these are of Palaeozoic age, but some may possibly be

Limestone hills, Sam Roi Yawt.

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older, such as the schists and gneisses of Puket and a series with pseudoslate, phyllite, siliceous slate and limestone gneiss at the base of Doi Chang in Northern Siam.

Palaeozoic Rocks

These rocks form the greater part of the exposed rock surface, both in Northern Siam and in the Peninsula. Their estimated thickness in the Peninsula is 47,000 feet and in the north 33,500 feet. They consist of shales, sandstone and limestone, the last usually recrystallized.

Fossil localities are rare; such fossils as have been collected are mostly of Permo-Carboniferous age. A collection of Carboniferous fossils has been obtained from limestone southeast of Pitsanulok; Permo-Carboniferous fossils have been collected in limestone west of Krabi and a few poor, undeterminable fossils in a limestone quarry at Ronpibun.

The limestone formations, of which there are several, furnish a striking physiographic feature of the landscape in Siam. Their outcrops extend intermittently from the southern border on the Malay Peninsula, at least as far north as Chiengrai. The outcrops form a disconnected and usually isolated series of sharp peaks rising steeply from the surrounding plain or hills to heights of several hundred feet. Exceptionally high is Doi Chiengdao which reaches over 7,000 feet.

Most of the limestone is highly recrystallized and in places even altered to marble; in general, bedding and stratification have been quite obliterated.

Mesozoic Rocks

In the north the only positive evidence of mesozoic rocks is from a syncline a few kilometres southeast of Chiengrai, where some fossils, reported to be of Middle Triassic Age, have been obtained.

Some beds in the Me Fang basin are also considered to be possibly Mesozoic as they contain a conglomerate with granite pebbles. The granite was intruded into Palaeozoic sediments, some of which are as late as Carboniferous, so it is inferred these beds are post-Palaeozoic, and similar beds have been described in

Indo-China as Lias. It is possible, however they may be early Tertiary.

In the Peninsula Mesozoic rocks have not been identified; it is probable that if deposited they have been removed from the region by pre-Tertiary erosion.

Tertiary Rocks

The Tertiary rocks, in the north and in the Peninsula, occupy limited basins isolated from one another.

In the north nearly all the basins are completely surrounded by steep hills of hard rock and are separated from each other by steep-sided rocky canons, younger than the basins they connect.

While it is probable that before the existence of the basins the surface had suffered erosion, these basins do not appear to be separate remnants of former valleys, on the contrary there seems to have been folding and faulting on a large scale, which produced the basins by subsidence of certain areas, irrespective of former valleys. It is not unlikely that the lower and stratified basin beds were deposited before the faulting, and that they represent downfaulted and infolded remnants of strata once wide spread over Central Siam.

Of this age, perhaps, are the extensive sandstone beds flanking the Korat and the Nakawn Tai plateaux, and forming the caps of the high mountains south of Lôi, of Kao Luang west of Sukotai and of the mountains to the east of the head-waters of the Kwe Noi in Kanburi Province.

Among the Tertiary rocks are several beds of lignite, most of which are thin.

Quaternary

In the Peninsula there are a number of clastic deposits, chiefly near the coast, which bear no internal evidence of being of Tertiary age, some of which, however, have suffered folding. Low dissected benches along the west coast, from 10 to 40 feet above sea level, indicate oscillations of level.

On the island of Puket are some beds of soft unconsolidated sandy clay and gravel which are considered to be of Pleistocene

age, as are also some deposits west of Singora and others between Hat Yai and Padang Besar.

In the north there are fairly large alluvial deposits in the larger valleys, but of much greater extent is the alluvium of the Menam delta and the coastal plains, all still being deposited.

Structure

Roughly the geological structure of Siam, excluding the eastern part of the country, may be described as a series of parallel folds running more or less north and south, into many, if not all, of which granite laccoliths have been intruded.

In the north of Siam, east of Chiengmai, four or five such folds can be traced; to the west of Chiengmai, which is unexplored geologically, there are probably others. In the peninsula, west of Tung Song, seven have been recognized.

Near the northern boundary of Siam some of the folds make a pronounced bend eastwards, while in the southern part of the Peninsula the general strike is N. 20 W.

Some of the folds noted in the peninsula probably continue their course under the sea. From the general trend of the folding it is probable that the granite southeast of Singora and granite islands east of Ban Dawn represent a granite laccolith with interrupted outcrop.

In the north it is extremely probable that there is important faulting in the region where the folds make a bend to the eastward.

In the Peninsula faulting is not infrequent. The most pronounced fault is on the mainland N. E. of Puket Island. This fault cuts with knife-like sharpness, separating a belt of limestone peaks on the west from the low Tertiary covered area in the east. Near the fault the limestone has been dragged down into a nearly vertical position and sheared zones and intense crushing are visible from the sea at several points.

The granites have also been under severe strains since their intrusion and they have probably been faulted.

Considerable folding of the Tertiary rocks has also taken place but this folding differs in character from the Palaeozoic folding. The folding of the Tertiary beds lacks regularity; not only do the axes of folding vary in direction but the folds are greatly inferior in magnitude to the Palaeozoic folds.

Hot Springs

Hot springs occur at many points scattered over the country. One of the largest and most spectacular is situated two hours journey northwest of Muang Fang, in an area of granite associated with metamorphic rocks. These springs issue from a space some 200 yards in diameter; twelve or fifteen columns of steam rise from as many springs, which are boiling violently and spitting water six to eight inches from the surface.

The existence of such hot springs suggests that there has been relatively recent igneous activity, the intruded rocks not yet having had time to cool since their intrusion.

At the northern boundary, near Hong Sawadī, there are two small and apparently dying volcanoes. In their craters are a few cracks from which smoke and sulphurous fumes issue.

Geological History

Present knowledge allows of only a very incomplete sketch of the geological history of Siam.

The record begins with the Palaeozoic, when the whole region was under the sea. This sea must have lain off the coast of some land mass which supplied sediment to form the relatively thick Palaeozoic deposits. This land mass may have been Gondwanaland; in which case the area now occupied by Siam would have been the sea off its northern coast. For a long period during the Palaeozoic, conditions were apparently quiet.

Of the Mesozoic times very little is known. It is probable that most of the deposits of that age have been completely eroded.

At the close of deposition folding began. Following the initial folding granite was intruded. This probably took place later than the beginning of the folding, for the axes of the folds are intersected by the granite. Most of the folding undoubtedly took place prior to the Tertiary.

Wave erosion of limestone rocks

At Sam Roi Yawt, now some miles from the sea.

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Following these disturbances, which raised the surface above the level of the sea, there appears to have been a long period of erosion, long enough to remove most of the Mesozoic deposits and reduce the surface approximately to a peneplain. No Tertiary deposits have been observed that do not lie on or near the top of the Permo-Carboniferous, so much erosion must have preceded their deposition.

In the Peninsula and in Northern Siam the Tertiary deposits occupy basins. It is probable that renewed thrusts, resulting in folding and faulting, and taking place during the late Tertiary, caused the sinking of the areas now occupied by the valley basins.

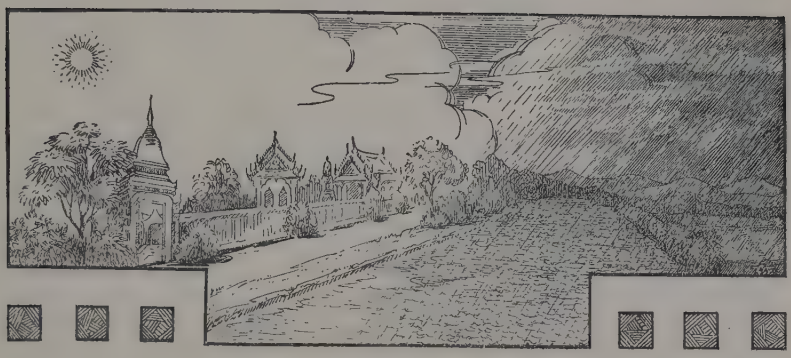
In the Quaternary fluctuations of considerable magnitude are indicated by the presence of marine shells in elevated caves, known at a number of points in the Federated Malay States. These suggest that various vertical movements of the land have taken place. In recent times, also, it is probable that there were lakes, or chains of lakes in the upper valleys of the chief tributaries of the Menam, while the site now occupied by the Korat plateau basin may have been an inland sea.

The erosion that is still going on has formed wide alluvial plains such as that of the Menam delta and those along the coast, as well as the smaller deposits in the larger river valleys.

There is some evidence that earth movements still continue in a mild way. At Sam Roi Yawt, limestone hills, several kilometres from the sea, and where there is but little alluvial deposit, show well marked wave erosion. Even in the life time of man it is said that the land there has advanced considerably.

Watching the turbid flood of the Menam during the rains we realize that the mountains of Siam are being slowly, but surely, carried into the sea. We know that the now viscous-solid magma on which the land floats is slowly, but surely, getting hotter; till at last it must inevitably reach its melting point, precipitating another great revolution, which may involve the sinking of Siam under transgressional seas. Some comfort, however, is to be drawn from the assurance of geologists that about 30 million years will

pass before these events take place. Long before that Siam will, in all probability, have extended her dominion over the sea, and where the fisherman now gathers his harvest at the fishing-stakes the husbandman will be reaping his rice.



CHAPTER III

CLIMATE

In a general way the climate of Siam corresponds with the classification made by Koppen and graphically illustrated in the map published with his book "The Climate Provinces of the Earth." Koppen rightly places that portion of Siam lying south of Prachuab Kirikan in the class of tropical rainy climates which have their rainy season divided into two parts with in between a short spell of dry season during the winter months. To the north of Prachuab Kirikan, but west of the Menam Chao Phya, the climate is warm with a dry winter and on the east of the Menam Chao Phya and on the east coast of Siam it is a periodical dry tropical rainy climate.

This classification is borne out by the diagrams of Normal Rainfall and the map showing the distribution of the Normal Rainfall, which have been prepared by the Meteorological Section of the Royal Irrigation Department. The map and diagrams are based on the rainfall figures of 20 years (1901-1921) at ninety stations distributed over the Kingdom.

The reason for fixing Prachuab Kirikan as the line of division of climatic conditions between the north and the south is be-

cause of the existence of a belt of poor rainfall immediately north and south of it, and because the greatest rainfall occurs in the months September—October to the north and in the months October—November to the south of it.

Seasons

The year which, according to the Buddhist Era, begins on the 1st April, may be divided into three distinct seasons, which for the north of Siam are :—

(1) The Wet Season, which begins about the end of April and lasts to the middle of November and which is entirely under the influence of the southwest monsoon.

(2) The Winter or Cool Season, which begins at the end of the Wet Season and lasts to the middle of February.

(3) The Summer or Hot Season, which extends from the middle of February to the end of April.

In the south, on the west coast of the Peninsula and west of the mountain range, the wet season exists during the same months as in the north of Siam but on the east coast of the Peninsula and east of the mountain range, the wet season is later beginning in August and ending in January to February, and because of its more southern latitude there is no distinct cold season.

According to statistics taken over a period of 20 years the average duration of the wet season in the north is 201 days, that of the longest, which occurred in the year 1925, was 236 days and that of the shortest, in the year 1920, was 174 days.

Rainfall

The average yearly rainfall for the Kingdom of Siam is 1600 mm. or 63 inches. The greatest rainfall of course occurs along the coastal region between Puket and Ranong, where the yearly average is as much as 3300 mm (130″). The rainfall in this region has never been less that 1300 mm. (51.2″) in any year, and the highest recorded at any one station was 6606 mm. (260″) at Takuapa in the year 1915, which figure is also the highest record for the Kingdom.

The region of least rainfall is that between Geng Koi and

Korat, where the average is only 880 mm. (34.64″), with a minimum of 273.6 mm. (10.77″), recorded at Nakorn Chantuk in the year 1923.

On the plains of Central Siam, where the paddy crop is cultivated on which Siam depends for its rice export, the average rainfall is only 1052 mm. (41.43″) during the rice growing season, which is made up of the following monthly averages, June 158.5 mm., July 178.1 mm., August 185.2 mm., September 269.2 mm., October 202.4 mm. and November 58.7 mm.; it will be noted the greatest rainfall occurs in the month of September.

Winds

Observations at the Meteorological Station at Rangsit show that the direction of the resultant of the surface winds gradually changes from east-south-east in January to west-south-west in September, and then suddenly returns to north-north-east and north between October and December. As the upper air currents affect weather conditions, it will be understood why the mountain range on the frontier between Siam and Lower Burma acts as a barrier to all the moisture laden winds coming from the Bay of Bengal during the monsoon season. This range causes most of the moisture to precipitate on its western side, and whereas the average rainfall for June to November for Lower Burma between Victoria Point and the Salween River is 4032.7 m/m, it is only 1052 m/m on the Plains of Central Siam.

The average velocity of the surface wind over the mainland, taken with a Robinson's windmeter is 4.18 miles per hour and the highest observed 5.65 miles per hour. Typhoons are generally unknown in Siam and only three Tornados, of limited areas but of considerable force, have been noted; the first occurred on the 31st March 1911 in Bangkok, the second on the 6th May 1926 at Dhanyaburi in the Province of Ayuthia, and the third on 12th December 1929 at Chumporn, doing damage nearing one million Bahts, when numerous tall trees were uprooted, buildings blown down and roofs of houses lifted.

Temperature

The temperature in Siam appears to be gradually increasing

and the range between the extremes is becoming greater. The yearly mean temperature in the shade in Bangkok, as observed by the Rev. Jesse Caswell for the period 1840–47, was 27.3 C (81.14 F), varying between 12.2 (54.0 F) and 36.1 C (97.0 F); for the period 1858–68 it was 26.7 C (80.1 F) as observed by Dr. F. Campbell and for the period 1902–11 observations made by Dr. Campbell Highet gave it as 28.3 C (82.9 F), with a variation between 11.1 C (52.0 F) and 41.1 C (106.0 F). The latest figures give the highest air temperature in the shade as observed on the 13th May 1926 to be 41.7 C (107.6 F). which brings the range between the absolute extremes to 30.6 C (55.6 F) as compared with 23.9 C (43.0 F) over the period of 80 years of observations.

The summaries of the meteorological observations made at Rangsit during the years 1925–1929 and at Chiengmai give a fair idea of the variations of weather conditions in Central and Northern Siam, and, although for two stations only, may be regarded as fairly representative of the weather characteristics in the Northern and Central parts of the Kingdom.

SUMMARY OF THE METEOROLOGICAL OBSERVATIONS

Made at Rangsit during the years 1925 to 1929.

AIR-TEMPERATURE IN SHADE	Cent.	Fahr.
Mean for period	28.44	83.19
Mean of Maxima	33.39	92.10
Mean of Minima	23·24	73.83
Extremes of daily means { Highest on the 30-3-28	33.50	92.30
Extremes of daily means { Lowest on the 26-2-28	19.96	67.93
Extreme Maximum on the 13-5-26	41.7	107.06
Extreme Minimum on the 3-2-25	12.8	55.04
Mean daily range	10.15	18.27
Greatest daily range on the 18-1-27	19.1	34.38
Smallest daily range on the 22-2-29	0.9	1.62
Range between extreme temperatures during period	28.9	52.02

SOLAR RADIATION (Maxima registered only)		
Mean of Maxima	64.08	147.34
Extremes of Maxima { Highest on the 13-5-29	75.2	167.36
Extremes of Maxima { Lowest on the 22-2-29	25.7	78.26

EARTH RADIATION (Minima registered only)		
Mean of Minima	21.54	70.77
Extremes of Minima { Highest on the 29-4-26	26.3	79.34
Extremes of Minima { Lowest on the 3-2.25	12.0	53.60

BAROMETRIC PRESSURE (Reduced to 0° C & 0.0 m. M. S. L.)	mm.	Inches
Mean for period	757.82	29.836
Extremes of daily means { Highest on the 22-12-25	756.06	30.120
Extremes of daily means { Lowest on the 8-10-27	753.13	29.651
Absolute Extremes { Highest on the 28-12-26	766.36	30.171
Absolute Extremes { Lowest on the 30-7-28	751.55	29.589

RELATIVE HUMIDITY	per cent.
Mean for period	75.09
Extremes of daily means { Highest on the 4-6-27	98.10
Extremes of daily means { Lowest on the 19-4-26	43.90
Absolute Extremes { Highest 173 times	100.0
Absolute Extremes { Lowest on the 6-3-28	21.6

EVAPORATION (Since 1st May 1926)	mm.	Inches
Mean for year	1475.34	58.804
Average for 24 hours	4.08	0.161
Extremes in 24 hours { Greatest from 13th to 14th June 1926	11.7	0.462
Extremes in 24 hours { Smallest from 22nd to 23rd Feb. 1929	0.3	0.010

NEBULOSITY (Cloud amount 0-10)	
Mean for period	4.8

SURFACE WIND	
Resulting direction of all observation	N 187° 19′ 55″ E
Dominating winds	S & SW
Average force for period (Bf. Scale 0 to 12)	1.9
Calms observed (in per cent of observations)	12.6%

RAINFALL	mm.	Inches
Average per year of rainy days (above 0.5 mm.)	103.2	
,, ,, ,, rainfall	1619.0	63.740
Maximum in one day observed on the 19-9-27	165.9	6.530
Greatest intensity observed in 17 minutes on the 27-8-25. ..	73.8	2.905

SUMMARY OF THE METEOROLOGICAL OBSERVATIONS

Made at CHIENGMAI during the years 1927 to 1929.

		Cent.	Fahr.
AIR-TEMPERATURE IN SHADE			
Mean for period		25.80	78.40
Mean of Maxima		31.51	88.72
Mean of Minima		20.25	68.44
Extremes of daily means	Highest on the 22-4-28 & 8-5-28	31.50	88.70
	Lowest on the 10th Dec. 1927	16.10	60.98
Extreme Maximum on the 23rd April 1927		39.8	103.60
Extreme Minimum on the 13th December 1927		9.2	48.56
Mean daily range		11.26	20.28
Greatest daily range on the 29th January 1928		21.5	38.70
Smallest daily range on the 7th September 1929		1.0	1.80
Range between extreme temperatures during period		30.6	55.04
SOLAR RADIATION TEMPERATURE (Maxima registered only)			
Mean of Maxima		50.13	112.23
Extremes of Maxima	Highest on the 4th April 1927	68.0	154.40
	Lowest on the 26th February 1928	22.0	71.60
EARTH RADIATION TEMPERATURE (Minima registered only)			
Mean for period		18.59	65.46
Extremes of Minima	Highest on the 23-6-29 & 6-7-29	24.5	76.10
	Lowest on the 30th January 1929	6.5	43.70

		mm.	Inches
BAROMETRIC PRESSURE (Reduced to 0° C & 0.0 m. M. S. L.)			
Mean for period		758.32	29.855
Extremes of daily means	Highest on the 29th November 1927	764.90	30.114
	Lowest on the 31st July 1928	751.37	29.581
Absolute Extremes	Highest on the 18th January 1929	765.3	30.130
	Lowest on the 31st July 1928	750.9	29.563

		per cent.
RELATIVE HUMIDITY		
Mean for period		72.46
Extremes of daily means	Highest on the 9th October 1927	95.33
	Lowest on the 18th April 1929	48.00
Absolute Extremes	Highest 5 times	99.0
	Lowest on the 12-2-28 & 11-3-28	25.0
NEBULOSITY (Cloud amount 0-10)		
Mean for period		5.5
SURFACE WIND		
Resulting direction of all observations		N 162° 40.′ 0″E
Dominating winds		N & S
Average force for period (Bf. Scale 0-12)		1.6
Calms observed (in per cent of observations)		7.03%

	mm.	Inches
RAINFALL		
Average per year of rainy days (above 0.5 mm.)	105	
Average per year of rainfall	1101.3	43.358
Maximum in one day observed on the 10th May 1929	75.5	2.997
Greatest intensity observed in 60 minutes on the 10-5-29	75.5	2.997

CHAPTER IV

FLORA AND VEGETATION

A great deal of work has been done on the flowering plants of Siam, beginning with the collections made here by Jean Gerard Koenig in 1778–1779; though even now they are by no means exhaustively known.

Collections of ferns and, to a less extent, of mosses, have been made by several collectors in various parts of the country, but, so far, little has been published on these classes. The plants lower in the scale, the fungi and algae, are almost unknown.

Most visitors to Siam see something of the flora and vegetation of Bangkok and its neighbourhood; so the plants of the capital will be considered first, though it must be remembered that they are very far from characteristic of the country as a whole.

The vegetation of Bangkok, indeed of the whole Menam Delta, has been profoundly influenced by man, who has been settled there for centuries, and it is, in consequence, almost entirely of a secondary character. There are good reasons for believing that before the advent of man the whole Delta, or as much of it as then existed, was one vast forest, and if man were now to

disappear from this region it would, in the course of centuries, almost certainly revert to forest again. With one possible exception, to be mentioned later, there is no remnant left of this primeval forest in the neighbourhood of Bangkok.

Apart from man the geographical situation of Bangkok and its climate have to be considered in relation to its vegetation. In this connection it is important to remember that Bangkok is a port of the Eastern Tropics, on a deltaic plain, raised but a few feet above sea-level and composed of a stiff alluvial clay, and that it is watered by a tidal river connected with a net-work of tidal canals. In the dry season, with less water coming down from up-country, the salt-content of the water in the river and canals always increases to an appreciable extent; in years with an abnormally low rainfall becoming distinctly brackish. A discussion on the climate will be found elsewhere. Its most important features in relation to plant life are the long dry season, when the ground becomes almost bone dry, and the following heavy rains which, combined with a rise in the river level, produce a water-logged condition of the soil lasting several months.

What follows refers only to flowering plants and ferns; too little is known of the lower plants to allow of their inclusion.

In some places along the river and larger canals, particularly where the banks are low-lying and submerged at high tides, we find the type of vegetation so often associated with tidal streams in the tropics, mangrove forest, or rather remnant of mangrove forest. This is best developed along the river below Bangkok, but patches of it are to be seen in Bangkok itself. It is, possibly, a remnant of the original forest of the delta; but even here it has to be remembered that the trees of which it is composed are frequently planted for the purpose of protecting the banks, or for firewood. The dominant, and often the only tree in the mangrove association as seen in Bangkok, and for many miles below it, is *Sonneratia acida*, called in Siamese *ton lampu*; the numerous spike-like pneumatophores from its roots presenting a curious appearance when seen sticking up through the mud at low tide. Of the smaller plants, not numerous in species, found in these

The lampu tree *(Sonneratia acida)*

At low tide, showing its spike-like pneumatophores.

mangrove swamps, the commonest is, perhaps, a spiny-leaved shrub with small white flowers, *Acanthus ebracteatus*. Where, however, trees are absent, for instance along some of the smaller creeks, a host of plants spring up on the tidal mud; such as numerous sedges (*Cyperus malaccensis, Scirpus grossus* and other species), the *Acanthus* mentioned above, a screw-pine (*Pandanus sp.*), a shrub or small tree with large round green fruit and white star-like flower (*Cerbera Odollam*), a coarse fern (*Acrostichum aureum*), and many others; over all straggle numerous climbers, among which may be mentioned the yellow flowered composite, *Wedelia biflora*, and a leguminous climber with white flowers, *Derris trifoliata*. In such neglected creeks the surface of the water is often hidden by a thick growth of water-hyacinth (*Eichornia crassipes*), water convolvulus (*Ipomoea reptans*), floating grass (*Hygroryza aristata*) or other aquatics. A somewhat similar vegetation is found on marshes, but in these the pink-flowered lotus (*Nelumbo nucifera*) is often cultivated, as it has many uses; its seeds and roots being eaten and its petals used for wrapping cigarettes. Other water lilies are also planted, such as various species of *Nymphaea*, with pink, white or blue flowers, or the giant-leaved *Victoria regia*. The last is intimately associated with the name of Sir Robert Schomburgk, a former British Minister in Bangkok, who, though he was not the first to discover it, sent home from Guiana the specimens and figures which were used in giving it its present name.

As the mouth of the river is approached the *Sonneratia* begins to give way to other trees of the mangrove association and we find there, among others, species of *Bruguiera, Avicennia, Xylocarpus, Ceriops* and *Rhizophora*. Here, too, there is an *Acanthus, A. ilicifolius*, similar in appearance to the Bangkok species, but with large, handsome, bright blue flowers.

There is another plant of the river side that will assuredly attract the attention of the traveller, and that is the nipa palm, *Nypa fruticans*, whose leaves seem to grow straight out of the mud. Large stretches of *Nypa* are to be seen, particularly towards the mouth of the river; but it must be regarded, on the Menam at

least, as a cultivated plant, grown for its leaves, which are used for thatching houses.

Beside the mangrove association the only tree vegetation to be seen in a natural, or rather semi-natural condition is the groves found in the grounds of some of the older temples. The trees of these groves were, no doubt, in the first instance planted, but they have since remained more or less unmolested, so that a natural vegetation, probably resembling that of the original forest, has grown up. Such groves are to be found at Wat Lum, on the west bank of the river just north of Rama VI Bridge, and at Wat Chawng Insi on the east bank, a little above River Station, the terminus of the line from Makasan. The most notable tree in these groves, and one readily recognized from the river, is the yang tree, *Dipterocarpus alatus*, perhaps the handsomest of the thousands of different trees found in the forests of Siam. Its smooth, pale grey, symmetrical bole often towers over 30 metres before branching. The yang belongs to the family of wood-oil trees, or *Dipterocarpaceae*, one of considerable economic importance and confined to the Indo-Malayan region.

The greater part of the remainder of the Bangkok vegetation is either frankly cultivated, or consists of light loving plants springing up on ground that has been left uncultivated for a longer or shorter period. In the rice fields we have a combination of both these, for during the greater part of the year the fields are uncultivated. However even when they are under cultivation there is a wild vegetation mixed with the crop. It is hard to imagine two more different conditions than the two that obtain in a rice field; at one season its clay deeply fissured and baked into an almost stony hardness, at another soft mud completely under water. Naturally such conditions deeply affect the vegetation and we find it has two well marked phases, a dry season one and a wet season one, in both of which the number of annuals is noteworthy. As the crop nears maturity the fields begin to dry up, and grass springs up among the rice, to spread and form a complete, but low, carpet after the rice is cut. The dominant grass in this carpet is a species of *Sporobolus*. In the

Rice-field flora in the rains.

Mimulus orbicularis, with round, floating leaves, and, nearer the centre, *Ottelia alismoides*, with larger leaves, can be seen.

rains, when the fields are flooded, most of these low grasses are killed off, their seeds lying dormant in the mud till the waters abate. But when the rice is planted numbers of sedges, some annual, some with perennial root-stocks, spring up with it, often to the detriment of the crop. Besides the sedges there are other weeds, annuals for the most part, in these flooded fields, several of them distinctly decorative, such as *Monochoria vaginalis*, var. *plantaginea* with dark blue flowers, *Mimulus orbicularis* with round floating leaves and pale blue flowers, and one of those interesting insect-trappers belonging to the genus *Utricularia*, *U. flexuosa*, with yellow flowers. The seeds of these plants, contrary to those of the grasses, are dormant during the dry season.

When the ground is allowed to lie waste for two or three years it usually supports a tangled scrub of shrubs and climbers, such as *Pithecolobium dulce*, *Azima sarmentosa*, *Capparis sepiaria*, these three armed with formidable thorns, *Combretum quadrangulare*, *Pluchea indica*, *Columella triflora*, *Coccinia cordifolia* and occasionally the rain tree, *Enterolobium saman*.

Between five and six hundred species of plants are known to grow wild in Bangkok and its immediate neighbourhood. Of these about 73% are probably truly indigenous, though most of them have a wide-spread tropical distribution, while the remaining 27% have almost certainly been introduced since the advent of man. The presence of this introduced element is not hard to understand. When the land was first cleared very few of the original forest species would be able to occupy the open, shadeless ground, consquently there was plenty of room for aliens who were otherwise constituted. Nor is it difficult to understand how these aliens arrived; to begin with the first agriculturists brought, no doubt, weed seeds mixed with their crop seeds. Again, it must be remembered that Siam has been in trade communication with her neighbours, both on the east and the west, with China and India, for many centuries, long before Europeans arrived here. During that period many useful plants must have been purposely introduced and also, inadvertently, others. These

last might come as seeds in the soil of purposely introduced plants or in cargo or ballast. Though the means of dispersal and the speed at which it can be effected have of recent years both greatly increased, it might be thought that all the available room for new plants was now taken up. This is not the case, for the introduction of new plants is still going on; some weeds that are now wide spread through the country were introduced less than fifty years ago. Two of these, both of tropical American origin, have become regular pests. One is *Eupatorium odoratum*, a rampant weed that quickly chokes forest clearings, to the exclusion of everything else; when in flower, in the cold season, it becomes a beautiful sea of pale lilac. This plant forms a very thick tangled growth, which can only be laboriously traversed with the aid of a knife. One of its many Siamese names, *ya sua mawp*, or the plant that makes the tiger grovel, refers to this difficulty of getting through it. The other is the notorious water-hyacinth, *Eichornia crassipes*, which rapidly multiplies in any piece of water that is stagnant or nearly so. At all times of the year it may be seen in marshes, creeks and protected recesses along the edge of larger waterways. With the rise of water in the rains it is washed out and comes down the river in masses, regular floating islands, eventually reaching the sea, where it may be met with even before land is sighted. Fortunately the plants cannot survive any length of time in salt water and at such a distance out they are in a dying condition. This pest seems to have almost ousted its rival, the water-soldier, *Pistia stratiotes*, which, twenty years ago, used to come voyaging down the Menam like a crop of lettuces afloat. The visitor will probably notice a roadside weed, *Ruellia tuberosa*, remarkable for its large purplish-blue flowers; another colonist from America, but hardly yet to be regarded as a pest. It is known that the water-hyacinth was purposely introduced, by way of Java in 1901, on account of its showy flowers; and, no doubt, the *Ruellia* was also imported by some keen gardener, apparently at no distant date, as it has only become noticeable in the last twenty years. In the same category of recent introductions comes the so-called Manila

The lampu tree *(Sonneratia acida)*

At high tide; the mass of vegetation floating on the water to the left is the water-hyacinth *(Eichornia crassipes)*.

cherry (*Muntingia Calabura*).

Tropical America, or the West Indies, has supplied 35% of the introduced plants that are now spontaneous. The remaining 65% come from various other countries.

The botanist from temperate climes may recognize in Bangkok a few plants that he is familiar with in his own home, but such species are few, and mostly of world-wide distribution: chiefly grasses like the dog's tooth or Bermuda grass (*Cynodon dactylon*), *Setaria verticillata* and *Echinochloa Crus-galli*; or water plants such as arrow-head (*Sagittaria sagittifolia*), sweet-flag (*Acorus Calamus*) and duckweed (*Lemna spp.*).

Turning now to the cultivated plants, which are more likely to impress the visitor than the wild ones, it is found that, of some three hundred of those most commonly in cultivation, about 26% come form Tropical America or the West Indies, 38% from other parts of the Tropics, while 29% are truly indigenous to Siam, but in the Bangkok area found only in cultivation; the origin of the remaining 7% is uncertain. If America has supplied many of our weeds, she has, on the other hand, originated some of our most useful as well as of our most ornamental plants. Among the former, to mention the commonest, are maize or Indian corn (*Zea Mays*), tapioca (*Manihot utilissima*), chillies (*Capsicum spp.*) and tobacco (*Nicotiana Tabacum*), while among the latter are Honolulu creeper (*Antigonon leptopus*), poinsettia (*Euphorbia pulcherrima*), bougainvillea (*Bougainvillea spectabilis*) and several species of *Allamanda* and *Canna*.

The trees planted along the Bangkok roads are not the least important of the cultivated plants; most of them are, however, aliens widely cultivated in the Tropics. The rain tree, *Enterolobium saman*, a native of Guiana, is one of the commonest, for it makes an excellent avenue tree. Others that will be frequently seen are the so-called mahogany (*Swietenia macrophylla*) from Honduras, the tamarind (*Tamarindus indica*), probably from Africa, the pradu (*Pterocarpus indicus*), possibly of Malayan origin, the sok tree (*Saraca Zollingeriana*), the Indian almond (*Terminalia Catappa*) and the kilek (*Cassia siamea*), the last

three being indigenous to Siam. Among the uncommon roadside trees, one, the krabao (*Hydnocarpus anthelminthica*), is noteworthy in that the oil from its seeds is now much used in the treatment of leprosy; a few rather poor looking specimens, recognizable in the fruiting season from their large, round, brown fruit, are to be seen along a street passing the water-works; it grows abundantly along some of the rivers of Siam. There is another tree (*Delonix regia*) which cannot be passed over in silence; a tree which painters of Bangkok scenery regard, not without reason, as almost indispensable. It goes by various popular names, such as "gold mohur," "fire tree" and "flamboyant", all descriptive of its appearance when in flower. Originally a native of Madagascar, it is now to be seen in many Bangkok gardens.

The real flora of Siam is very different from that of Bangkok. Siam stretches through over 14 degrees of latitude, commencing in the south within 6 degrees of the Equator, has a long sea-board and mountains running up to 2,500 metres in height, so naturally her flora is a rich one, probably reaching nearly 10,000 species of flowering plants. Not least as a cause of the diversity of species are the differences of climate to be met with, from the moist climate, with no well defined dry season, of her southern provinces to the marked alternations of dry and wet season found further north.

The considerable collections made within the last ten years or so have not yet been completely worked out, so exact figures for all the families are not available. Among the largest families are:— Orchideae, Leguminosae, Rubiaceae, Euphorbiaceae, Gramineae, Cyperaceae, Acanthaceae, Anonaceae, and Melastomaceae. The largest genera, containing probably 30 or more species, are:— *Desmodium*, *Dalbergia*, *Bauhinia*, *Eugenia*, *Begonia*, *Diospyros*, *Ipomoea*, *Piper*, *Ficus*, *Dendrobium*, *Bulbophyllum*, *Eria*, *Dioscorea*, *Calamus* and *Cyperus*. The species of *Eugenia* have been worked out, and number 80. *Ficus* and *Dendrobium* will probably prove to be as rich, if not richer, in species.

In that part of Siam which lies in the Malay Peninsula, south of about Lat. 10° or 11°N, the flora is distinctly Malayan.

Pa Deng

The large tree in the foreground is *Dipterocarpus intricatus*.

Northwards of this, including the great bulk of the country, the flora may be regarded as part of the fairly homogeneous flora that occupies most of the Indo-Chinese Peninsula, from the Bay of Bengal to the Gulf of Tonkin. Nevertheless, the Siamese flora shows a considerable amount of endemism; between 19 and 20% of the species so far named have not yet been recorded outside Siam.

When the distribution of the floral components is examined more in detail some interesting points come out: such as the extension southwards of numerous elements from the Eastern Himalayas and Assam along the range of mountains stretching down the western border of Siam into the Malay Peninsula, without a correspondingly large extension northwards of the Malayan flora occupying the southern portion of the Peninsula. Curiously enough Malayan types seem to extend further north on the eastern side of the Gulf of Siam, in the Circles of Chantaburi and Prachinburi. Climate is, no doubt, the chief factor concerned here. Recent geological history must also be taken into consideration; for there is some evidence that the southern part of the Malay Peninsula was cut off by sea from the main land for a considerable period. Those who wish to pursue this subject further will find interesting observations on the affinities of the Siamese flora in the introduction to Professor Craib's "Florae Siamensis Enumeratio."

About half the area of Siam is hilly, and nearly 70% of the whole surface is forest clad. These forests, naturally of great importance to the country, show considerable diversity in composition, but only the principal types can be alluded to here. In the first place, as the commonest type, probable exceeding 50% of the forested area, comes the association known in Siam as 'pa deng' (red forest), a deciduous open forest of small or medium sized trees, the dominant being *Shorea obtusa* and *Pentacme siamensis*, both belonging to the family of wood-oil trees, with an abundant herbaceous undergrowth, chiefly grasses. This type of forest covers large areas in Northern and Eastern Siam and is usually found on rather poor, lateritic, sandy or rocky soils. Further

south, on somewhat similar ground, another forest is more often seen; this is an evergreen forest, which may be called dry evergreen forest, consisting chiefly of small, fairly closely set, evergreen trees, with a few scattered large trees, the latter often deciduous, and very scanty herbaceous undergrowth. The species here are more diversified than in the 'pa deng'. *Hydnocarpus ilicifolia*, *Murraya exotica*, *Atalantia monophylla* and *Taxotrophis ilicifolia*, all with the rather leathery, dark green, leaves characteristic of this forest, may be mentioned among its common trees.

The most valuable timber trees are to be found in a third type of forest, the mixed deciduous forest, which is best developed in the larger valleys of Northern Siam, and contains numerous fine trees, most of them deciduous, such as teak (*Tectona grandis*), redwood (*Xylia Kerrii*), pradu (*Pterocarpus macrocarpus*) and the wild mango (*Mangifera spp.*).

In the southern part of the Peninsula, and in the south-eastern corner of Siam, are to be found large areas of lofty evergreen forest, agreeing with the popular conception of tropical forest and usually known as tropical rain forest. The number of species of trees in these forests is very great and has been placed at 200 or 300 to the square mile. The average height of the trees is between 30 and 60 metres, most of the giants belonging to the wood-oil family, or *Dipterocarpaceae*. The frequent presence of palms, erect, and climbing, adds to the tropical appearance.

Bamboo forests are particulary well developed in some parts of Western Siam and Northern Siam. In recent years more and more attention is being paid to the bamboo as a source of paper pulp. The extensive bamboo forests of Siam should lend themselves readily to this industry. Mention, must also, be made of the pine forests and open hill forest, with oaks and chestnuts, of Northern Siam. The most extensive pine forests are composed chiefly of *Pinus Merkusii*, a two-needled pine, and are best developed on uplands at about 1,000 metres elevation above sea-level; though the tree may be found at much lower altitudes. This pine, when tapped, gives a good flow of turpentine, and is already being exploited to a certain extent. Another species of pine, *Pinus*

Vegetation on Limestone

The two tallest trees are *Euphorbia antiquorum*, while the branching shrub on the right is a species of *Pandanus*.

insularis (*Pinus khasya*), with needles in threes, is found at somewhat higher elevations, but does not yield turpentine so readily. The mangrove forests, most extensive on the west side of the Peninsula and on the east side of the Gulf of Siam, have already been touched on.

On the tops of the highest hills, at and above 1,500 metres altitude, some temperate genera are found, like *Viola*, *Gentiana*, *Primula*, *Saxifraga*, *Rhododendron* and *Rosa*. One rose, however, *R. clynophylla*, flourishes quite low down, along the Me Kong and some streams draining into it.

The visitor who travels by the Royal Siam State Railways can see a good many types of vegetation, but he must remember that timber felling has usually altered the natural appearance of the forest close to the line. A brief sketch of some of the chief types of vegetation to be seen from the main lines, beginning with the Southern Line, is given below.

After passing Padang Besar on his way north the traveller sees chiefly a rather thick growth of secondary forest, that has come up on old clearings A low, spreading bamboo, *Gigantochloa ligulata*, with very broad leaves, is common here, and rubber plantations are frequent. Seven or eight kilometres north of Hat Yai the train passes large tracts of open forest, consisting almost entirely of a rather small tree with a pale flaky bark, a forest which, to the Australian, must be reminiscent of the bush. The tree here is *Melaleuca leucadendron*. The leaves of this tree contain cajaputi oil; but, unfortunately, the yield, as far as the trees here are conerned, is rather low. A little further on will be seen the beginning of a number of limestone hills rising abruptly from the plain. These hills have a peculiar, and very interesting vegetation of their own; among their more striking plants being a cactus-like *Euphorbia*, and species of *Dracaena* and *Pandanus*. Here too there are wide stretches of open grassy savannah with scattered clumps of trees. Growing among the grass of these savannahs are many small plants with striking flowers, such as a white-flowered dwarf *Holarrhena*, *Exacum tetragonum* with white and blue flowers, a curious dwarf *Dillenia* (*D. Hookeri*), with large

yellow flowers, and a *Decaschistia* with bright pink, hibiscus-like, flowers. Near Ta Samet station is an interesting association; a low growth on sandy soil, having as its dominant plant a feathery shrub, *Baeckea frutescens*, not unlike a tamarisk. With the *Baeckea* grows the cajaputi tree, usually only a shrub in this association, and a plant that will be familiar to most travellers, the common bracken (*Pteridium aquilinum*). The forests about Tungsong, and the long stretch from Tungsong to Chumpawn are passed in the night. After passing Chumpawn the line runs through a rolling open savannah, grassy hills with here and there a few scattered trees, that extends for about 60 kilometres. This country was once thickly forested, like that to the south of Chumpawn, but the forests have been destroyed, chiefly through the system of clearing-cultivation. It is said that these forest were wrecked by a typhoon, which occurred about sixty years ago, and no doubt that typhoon was responsible for some of the damage. Now annually recurring grass fires prevent the re-afforestation of the area. The grass here is that planters' bane, lalang (*Imperata arundinacea*). It will be noticed that many of the remaining trees, often standing, like sentinels, alone on the hill-tops, are palms (*Livistona sp.*). Along the stream courses a a tall screw-pine (*Pandanus furcatus*) is common.

At Hui Yang, and again at Kan Kradai, the high hills of the border range come close to the line and their dense covering of forest, from foot to summit, can readily be seen. On the upper slopes this forest is evergreen, but on the lower slopes there is a good deal of a small bamboo known as ruak (*Thyrsostachys siamensis*). At the stations in this region stacks of logs will sometimes be seen. The large logs are usually those of pradu (*Pterocarpus sp.*), while small logs are often valuable ebony, obtained from species of *Diospyros*. Northwards from this there is much secondary growth, and open scrub, often with quantities of a thorny bamboo (*Bambusa arundinacea*), interspersed with patches of rice fields. As Petchaburi is approached numbers of toddy palms (*Borassus flabellifer*) are to be seen growing on the bunds of the fields. These palms are the chief source of sugar in

this part of the country. On their trunks may be noticed epiphytic species of *Ficus*, tightly enmeshing their host with a net-work of anastomosing branches. In the same situations an orchid (*Cymbidium sp.*) is also not uncommon.

After passing Petchaburi the country is chiefly cultivated, but the line runs through some salt marsh with its characteristic vegetation. Common components of this, to be seen from the train, are a large, coarse-looking fern (*Acrostichum aureum*), the marsh date (*Phoenix paludosa*), a shrub with bunches of small dark fruit and heart-shaped leaves (*Thespesia populnea*), also *Hibiscus tiliaceus* and *Rhizophora conjugata*, the last, easily picked out by its numerous prop roots, will often be seen in regular blocks, as it is cultivated for firewood and poles. Where the ground is clear of larger growth, a herb (*Suaeda sp.*), with fine feathery foliage, sometimes tinted red, often takes possession of the terrain.

After passing Ban Pong the great deltaic rice plain of the Menam is entered and continues to Bangkok.

Leaving Bangkok by the Northern Line the rice plain is traversed for about 180 kilometres, when some low open forest and bamboo clad hills may be seen. In this poor looking forest the traveller may catch a glimpse of some striking flowering trees, such as *Lagerstroemia floribunda* which comes out in a crop of mauve flowers during the rains, or *Cassia Fistula* with a profusion of yellow bloom in the dry season.

It is not, however, till the train passes Utaradit and enters the hills that well-forested country is met with, though even here much of it has been felled. The low hills seen after passing Me Puak are chiefly covered with mixed deciduous forest containing plenty of teak, recognizable by its large leaves, or when the leaves have dropped, by the panicles of dry fruit sticking out from the top of the tree; in the rains its sprays of white blossom may be seen.

In the valley of the Me Yom the upper parts of the hills are entirely clothed with 'pa deng', while on the lower slopes there is mixed deciduous forest with teak. From this point on to

Chiengmai pa deng is the forest most commonly seen, the mixed deciduous forest keeping chiefly to the valleys, except between Ban Me Chang and Ban Me Maw where the line runs through a stretch of bamboo (*Thyrsostachys siamensis*).

Space does not allow of a detailed account of the vegetation to be seen on the other lines, but mention may be made of a forest that is traversed on the Northeastern Line before reaching Korat. This is a dry evergreen forest that covers the comparatively level stretch round Muak Lek, and which used to be known as the Dong Paya Fai, a name referring to its evil reputation for fever. The characteristics of this type of forest have already been mentioned; it cannot be well seen from the train owing to the wall of creepers that have grown up on the faces of the forest edging the line. Between Korat and Ubon the forest passed through is chiefly 'pa deng'.

On the Eastern Line many kilometres of 'pa deng' are passed through between Aran Pratet and Krabin. Here are to be seen several other wood-oil trees, besides the characteristic *Pentacme siamensis* and *Shorea obtusa*, chief among them being three species of *Dipterocarpus*: *D. obtusifolius*, *D. intricatus* and *D. tuberculatus*. In the more open parts of this forest are to be seen the same brightly coloured flowers as those of the savannahs along the Southern Line. In this section lumbering is going on in the forests back from the line, and a variety of logs will be seen stacked at the stations. Among them are those of pradu and payung, the latter, the produet of *Dalbergia cochinchinensis*, is a handsome dark-red wood, one of the most valuable in the country.

From Krabin on to Bangkok there is little to break the monotony of the rice plain, but an occasional grey-green clump of small sakeh trees (*Combretum quadrangulare*).

The reader who would like to obtain further information on the botany of Siam is referred to Professor Craib's "Florae Siamensis Enumeratio" (Bangkok Times Press), four parts of which have been published, the first containing a good bibliography of works relating to the flora of Siam and neighbouring countries.

CHAPTER V

FAUNA

MOLLUSCS

The molluscan fauna of Siam, marine, fresh-water, and terrestrial, is abundant and varied. It partakes of the general character of that of adjoining countries and does not present any important distinctive features so far as known.

Most abundant and important of the marine molluscs are the sea mussels of the world-wide genera *Mytilus* and *Modiola*, which occur on suitable bottom on all parts of the coast and are extensively utilized. At least two species of edible oysters (*Ostrea*) of excellent flavor occur, and reach a large size within the influence of fresh-water streams.

The family of ark shells (Arcidae) is abundant, and about 10 species of the type genus *Arca* have been found. They serve as a rather important local food in the coastwise communities. Cockles, clams, and other similar bivalves of the families Cardiidae, Veneridae, and Mactridae abound as to both species and individuals; and the family of razor-clams (Solenidae) is represented by 4 or 5 speces of as many genera.

Familiar objects cast up on the sea shores are the extremely

thin and translucent valves of the window-pane shell (*Placuna orbicularis*), widely used in the Philippine Islands for the purpose indicated by its name. There abounds also in certain localities the larger, equally thin, saddle-shaped shell (*Placuna sella*), with a beautiful nacre in iridescent hues, gathered for its minute pearls which are used as medicine by the Chinese.

Shipworms (Teredidae) of at least two genera are widely distributed in salt, brackish, and even fresh water, and do great damage to piling, boats, and submerged wood generally. They are eaten in various places and by some persons are highly esteemed.

Among the numerous species of marine univalve molluscs, common and well-known genera are *Conus, Pleurostoma, Oliva, Mitra, Turricula, Alectrion, Murex, Urosalpinx, Morula, Cuma, Pyramidella, Odostomia, Bursa, Cypraea, Strombus, Cerithium, Potamides, Natica, Turbo, Trochus,* and *Nerita.*

The fresh-water mussels (Unionidae) belong to half a dozen genera, and in some streams, especially those with sandy bottom, are very abundant. The fresh-water snail family of Lymnaeidae contains members of the familiar genera *Lymnaea* and *Planorbis.* Conspicuous fresh-water molluscs in ponds, swamps, and streams are the so-called apple snails (Ampullaridae) of which 7 local species of the genus *Pachylabra* have been described; these are the largest of the fresh-water gastropods. Tree snails (Bulimulidae), some of them showing great variety and beauty of shell coloration, are found in suitable situations in both low lands and mountains; and land snails (Helicidae) of several genera abound. The ubiquitous family Viviparidae, fresh-water snails which bring forth their young alive, is represented in Siam by at least 4 species that have been found from Chiengmai to Singora.

The highly-specialized molluscs constituting the sub-class of Cephalopoda are well represented in Siam by octopods, cuttles, and squids. No systematic work on them has been attempted, however, and the local genera and species are undetermined.

INSECTS

Of the Lepidoptera of Siam, it may be said that the list of the Rhopalocera (Butterflies) is now approaching completion, but that

Three Siamese Butterflies.

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of the Heterocera (Moths) is only in its initial stage. The total list of the Butterflies stands at present at about 700 species, of which 140 have been recorded from Bangkok. It is interesting to note that collectors were at work in the country as far back as 1770, for *Clerome arcesilaus* was described by Fabricius from Siam in that year. The type of this butterfly, which probably came from Chantabun (S. E. Siam), is preserved in the Banksian Cabinet in the British Museum.

The study of the butterflies has proved of great interest in that it has (*a*) brought out the very real faunistic differences of the various divisions of the country, (*b*) provided many very striking examples of the high susceptibility of certain butterflies to the influence of contrasting seasons—wet, dry and intermediate.

The most conspicuous of the butterflies to be found in Bangkok is *Papilio aeacus*, which, on account of its size, is known to the Siamese as "pee sŭa yak" ("giant butterfly") and which is the only butterfly in the country having a distinctive name. The males and females of this butterfly are very partial to the flowers of the "flame-of-the-forest" *(Delonix regia)*, and when this tree is in full bloom the combined effect of masses of vivid scarlet blossoms with the numerous conspicuous butterflies hovering over them in distinctly pleasing to the eye.

In the forests of the country are to be found some of the most striking and the most beautiful butterflies in the world. Of the "striking" butterflies may be instanced *Kallima inachus* (commonly known as the "leaf-butterfly") which, on account of the extraordinary protective colouring of its under surface, has excited interest from the time of Wallace onwards. The two lower specimens figured on the plate opposite are of interest as they represent separate subspecies. The larger and lighter coloured specimen (fig. 3), obtained at Muak Lek (E. Siam) is *K. i. siamensis* Fruhst.; the smaller, darker coloured one (fig. 2), obtained near Chiengmai (N Siam), is *K. i. limborgi* Moore.

As stated above, the study of the moths is far behind that of the butterflies. It is interesting to note, however, that a casual

collection made in Siam and worked out at the British Museum contained 375 species, of which 14 were new to science. The proportion of 14 new species, to 375 recorded, is sufficiently high to justify the opinion that there is a rich field for future workers, especially as the final list of the moths will run into thousands. Since the foregoing was written, a further large collection sent to London has already added 200 species, 20 of which were new, to the lists of Siamese moths.

Moreover, apart from the compilation of lists and the pleasure of describing (or recording) new species, there is always the interesting task of working out the life-histories of moths, especially those whose larvae must be regarded as insect pests. Something has been done in this direction by The Bureau of Agricultural Science, and lists of injurious insects have been compiled and published. The most important crop is rice and the majority of the serious pests of rice are the larvae of moths. Rice cut-worms are caterpillars of various species of moths, the most important being *Prodenia eitura*, *Spodoptera mauritia*, and *Cirphis unipuncta*. In between the rice seasons the first lives on grass or on anything or everything found in the ordinary market garden or vegetable patch. Thus it is easily the most persistent of the group. On the other hand the caterpillars of *Cirphis unipuncta* appear in very great numbers suddenly and at irregular periods. They occur particularly in years in which there are early rains and a drought followed by heavy rains. The moth is about 44 mm. across the wings, pale brick red or very pale brown in colour with dark specks and blotches. The stem-borers are responsible for serious damage, the amount of which varies from year to year. They are the caterpillars of moths that are prominent throughout the rice season, the number reaching their maximum in September, October or early November.

At this time of the year one notices every evening an invasion of small moths crowding round the electric globes, fluttering here and there on the walls, but never getting far away from the light. Prominent amongst these is an insect with buff coloured forewings, on each of which is a small black dot, the underwings are white

and silky with a fringe along the margin nearest to the tail. The body is white, about ½ inch long, and the wings when spread out have an expanse of about one inch. In close attendance to these is seen a somewhat smaller moth, the forewings a darker brown in colour with a row of tiny dots along the outer margin, almost invisible without a magnifying glass, the underwings are similar to those of the first mentioned insect.

These moths are respectively the female and male of *Schoenobius incertellus (bipunctifer)*, the paddy stem borer. Often one sees on the wall near where the insects were be-sporting themselves, a small mound like mass covered with yellow hairs —these masses may be as much as ¼ inch broad and nearly ½ inch long, and consist of the eggs laid by the misguided female and provided with a protective layer of hairs detached from her hinder end. These are fated to be devoured by ants, or, if they hatch at all, the tiny caterpillars soon die for the want of food, or become the prey of small spiders.

Unfortunately only a small proportion of the eggs are laid in such harmless positions, the remainder being deposited on grass or on paddy, either of which form a hospitable home for the brood which hatches out in about one week's time. The little worms or larvae are dark brown or black in colour with big heads, they are very light and are often carried long distances by the wind. They start by eating the leaf on which they find themselves and working their way quickly to the base of the leaf they soon bore right into the stem of the plant. Here they entrench themselves securely and proceed to intercept the nourishment that the plant is passing upwards to its growing point; sometimes 10 or 12 of these robbers may be found on a single stem, but, as they grow older and more voracious, they are less tolerant of table companions, until nearly full grown, when one stem will harbour one larva only. The full grown larva or caterpillar is about 2 cm. long and 3 mm. in diameter, its colour is variable, dull white or yellowish with a green tint, head orange yellow or dark brown. The body is sparsely covered with hairs. If you open carefully the stem of an affected plant you will see the borer snugly hidden in his little

cell, carrying out in secret his fell work of destruction. The conditions being favourable the larva, after eating almost continuously for many weeks, does a final moult and becomes a pupa, or chrysalis, with a hard shell conforming roughly to the shape of the larva. The pupa is almost white at first but soon darkens to brown and finally becomes red-brown. After 8 or 12 days the adult moth opens the end of the pupal case and passes out into the air through the hole in the stem, which, with great foresight, was provided by the insect when in the form of a caterpillar.

If the conditions are not favourable the larva will rest for several weeks without eating and then after a few square meals it will pupate as mentioned above.

Going through the fields at harvest time one notices here and there ears of paddy which, instead of being golden full and heavy are white and empty. This is the result of the attack of the paddy borer. Careful observations will reveal other plants of stunted growth on which the central heart-leaf has died and caused the death of the whole plant long before maturity. These are plants that have been attacked early in their life.

Other stem borers are *Sesamia inferens* and *Diatrea sp.* They are all kept in control by parasites of which a small chalcid fly is the most important. In October 1929 a large number of Schoenbius egg masses were collected and over 90% were found to be parasitised by these useful insects.

The most conspicuous of the moths is the huge atlas moth (*Attacus atlas*) with reddish brown wings in which are noticed transparent sections like windows. The caterpillars of these moths are voracious feeders and can do a lot of damage to trees, particularly citrus and guava, in a very short time. Various kinds of hawk moths are common and their rapid flying is in great contrast to the slow moving atlas. The oleander hawk-moth (*Deilephila nerii*) is particularly handsome with its beautifully marked green and brown wings.

Dragonflies revel in the air of Bangkok, as water-ways are to be found everywhere. Some are of very large size, while all are beautiful. There are many hundreds of species in Siam, 82 of

which have been identified, including 5 new species.

Diptera are well represented, particularly by the ubiquitous mosquito; the anopheline that stands on his head to suck one's blood being quite common. Sixteen species of *Anopheles* are known from Siam, some of which are malaria carriers. The black-and-white striped mosquito is a great nuisance in the daytime, its persistent buzz being very distracting and its rapid movement renders abortive many an attempt at destruction. The study of the Diptera promises to be even more interesting than that of the moths. Two small collections have been sent to the British Museum, representing about 100 species of which 20 are new. Of the Orthoptera, the grass-hoppers are the most, numerous, one cannot walk anywhere through the grass or paddy or in the jungle, without these creatures jumping or flying in front. The short-horned grass-hoppers are more common than the long-horned. In the paddy fields, in addition to the typical grass-hopper the Tryxalinae and Pyrgomorphinae are frequently seen with their rather slender bodies, chinless heads and flattened antennae. Most of them appear to be semi-amphibious in their habits and are able to swim for short distances on the surface of the water. A new species described by Uvarov was discovered at Klong Rangsit and called *Quilta oryzae*. It has the hind tibiae expanded, obviously an adaptation for swimming. The long-horned varieties (Locustidae) are rarer, but they are seen more in the jungle. Some of the katydids with their large hind wings closely resemble leaves.

Cockroaches (Blattidae) are found in the houses in every nook and cranny, lurking in drawers, under papers, and usually come out only at night; but many species live outdoors and fly to light, while wingless species are found hiding under the bark of tree. The predominating colour is brown, but some are jet-black while others have black and yellow markings on a brown ground.

The praying mantises (Mantidae) arrest notice with their front legs held up in an attitude of prayer, while their big eyes and roving head give them a curiously alert look. Both form and colour of these insects are cryptic, the wings usually resem-

bling closely the leaves of trees. There is a species in Siam less than ½ inch in length, but the larger sizes are much more common and sometimes reach a length of six inches. The stick insects (Phasmidae) are particularly numerous in the jungle, their long slender bodies giving them a remarkable resemblance to twigs and leaf petioles.

The mole-cricket (*Gryllotalpa africana*) leaves his burrow at night and flies into the houses, running quickly here and there, or trying to bury himself in the carpet. He is a loathsome looking object with a soft body and powerful front legs, looking rather like hands, and is not at all popular with the ladies, getting entangled in their hair or climbing up their legs.

Beetles (Coleoptera), from the tiniest microscopic species to the big longicorns and the terrifying rhinoceros beetles, are plentiful, although not more than 200 species have been identified. Of the Carabidae, the tiger beetles are very noticeable as they fly readily to light; they have greenish blue iridescent bodies, some with yellow and red spots on their backs. *Cicindela sexpunctata* is said to exert its carnivorous tendencies on the paddy-fly (*Leptocorisa sp.*), which might otherwise be a very serious pest. A brown and black beetle, *Pherosophus sp.*, is one of those that visit the dinner table, running with great rapidity over the cloth—beware how you handle it, however, for on the slightest provocation, it will eject, with a loud report, nasty-smelling, corrosive liquid from behind. The rhinoceros beetle is a heavy looking insect, rather broad in proportion to its length, with a blunt horn on its forehead, the undersurface covered with a mass of auburn hairs. He flies towards the light, apparently trying to dash his brains out against the walls, generally ending up on his back waving his legs helplessly in the air. This insect causes a lot of damage to the coconut and sugar palms, making wounds in which the palm weevil lays its eggs. The beautiful buprestids (metallic wood-borers) are common in Siam, particularly a large insect nearly 1½ inches in length (*Sternocera equisignata*). It is a bright metallic iridescent green, and its whole body reflects the light so that it appears to change from

green to copper-red according to the point of view. The Chinese breed these insects for use as brooches.

The tortoise beetles (Cassidinae) are found on the leaves of most plants. Some of them are beautifully coloured, shining gold and green ; this colouring fades on death, but may be renewed partially by prolonged immersion in pure water. The useful lady-birds (Coccinelidae) are prevalent everywhere and vary in size from a tiny pea to those the size of a five satang piece. The colouring is warning, mostly red, with or without black spots. There is a large variety of long-horned beetles of all sizes, ranging in colour from dull greys and browns to bright orange and red. They emit an audible squeak when caught. One particularly striking individual (*Aristobia approximator*) has the elytra covered with irregular-shaped golden yellow spots and blotches on a black ground. The antennae are long and yellow, each with a tuft of black hair between the first and second segment and looking like a flue-brush. The Lampyrinae or fire-flies may be seen at night in damp situations, decorating certain trees like Christmas candles that are lit and extinguished with great regularity and in perfect unison.

The Hymenoptera are well represented, bees, hornets or wasps, and ants being ubiquitous. The ichneumon and chalcid flies play a very important part in keeping in check the various insect pests of padi and other crops of economic importance. The solitary wasps, or house hornets, build their nests and cells in odd corners of the house and small bees fill up the keyholes and crevices with mud as a home for their young. The house hornets are useful in keeping down the Lepidoptera, as they fill their cells with caterpillars that have been stung into a state of paralysis, as food for their progeny. The Chrysidae or cuckoo-wasps follow their activities with great interest. These are conspicuous insects, bright metallic green or blue in colour with drab wings. They fly around looking for a convenient mud nest or cell in which to push their sharp ovipositor, laying an egg from which will hatch out a larva that will usurp the position of the rightful owner. The big carpenter-bees may be seen taking their

nourishment at the flowers in the garden or buzzing round the posts in which they have made their home. They do a considerable amount of damage to the wooden telephone and telegraph poles.

The bugs (Rhynchota) are much in evidence, above all the small green fly, a jassid, that swarms round the electric lights. The giant water bug (*Lethocerus indicus*) is often seen and is much appreciated as a great delicacy. The cicadas are heard singing in the trees making a wonderful noise for their size. Red cotton bugs are common everywhere, living on Hibiscus and other Malvaceae, and often, during one's walks abroad, handsome pentatomids with shiny green backs, spotted with black, yellow or green, may be found resting quietly on leaves by the road side. A large variety of reduviid bugs come to light. The black species with orange or red lines on their elytra can and will inflict a painful stab with their sharp proboscis if attempts are made to capture them with the bare hand.

Of the thrips (Thysanoptera) a list of 22 species, 11 of which were previously unknown to science, has been published.

Some forms related to insects may be conveniently mentioned here. Of these perhaps the most interesting is that primitive worm-like genus *Peripatus*, a species of which has been found in the mountains of the south. The centipedes and millipedes (*Myriapoda*) are well represented, but the species have not yet been worked out.

CRUSTACEANS

The waters of Siam abound in crustaceans, but this class of animals, with the exception of the crabs, has received scant attention from zoologists, and little or no research has been devoted to some of the orders, this being particularly true of the small forms belonging to the Copepoda, Amphipoda, and Isopoda, although they are of great importance as food of the higher animals, especially the fishes.

The most noteworthy of the crustaceans are the shrimps, of which there occur scores of species belonging to the genera *Peneus*, *Penaeopsis*, *Parapenaeopsis*, *Acetes*, *Leucifer*, *Crangon*, etc. The

Tale Sap, or Inland Sea, at Singora is noted for the variety and abundance of shrimps. In the rivers there abound large, long-legged prawns (*Macrobrachium*), of many species, which sometimes attain a body length of 25 cm.

Crabs are in considerable variety. In salt water are large swimming and bottom-living crabs of several genera of the families Cancridae and Portunidae, the most important being *Scylla serrata*; in streams there is an interesting group of river crabs (Potamonidae), with 12 known local representatives; while on the shores and flats are fiddler crabs (Ocypodidae), hermit crabs (Paguridae), and various other forms together with large land crabs.

The order Stomatopoda, comprising the so-called mantis-shrimps, has 8 or more local species belonging in the genus *Chloridella* or *Squilla*, some of which have brilliant colours and some attain a size (30 cm.) rivalling lobsters. They are caught incidentally in the net fisheries of the coastal waters and are often seen in the markets.

The order of barnacles (*Cirripedia*) is represented locally by a great profusion of acorn barnacles (*Balanus*) which encrust rocks and timbers, and by goose barnacles (*Lepas*) and other forms.

The arachnoid order Xiphosura, which comprises the king-crabs or horseshoe-crabs, with an almost world-wide distribution, is represented in Siam by two species. One, *Tachypleus gigas*, locally called "mangda", common on sandy beaches in the Gulf of Siam, is extensively caught for its eggs, which are considered a delicacy. The other, *Carcinoscorpius rotundicauda*, known in Siam as "mangda fai", "mangda tuey", and "he-ra", is highly poisonous to human beings, at least at certain times, and deaths have occurred from eating the eggs.

FISHES

The coasts of Siam are frequented by a vast array of fish life, comprising some of the best and commercially most valuable fishes of tropical seas. Some of the fishes are wide and erratic roamers, and individuals may in the course of a year come within

several national jurisdictions; some free-swimming forms have, within comparatively narrow limits, definite and regular migrations that are effected by, or at least coincide with, the monsoons; and some shore and bottom species are more or less sedentary or at least undergo no extensive migrations. Important commercial fishes belong in each of these categories. The Gulf of Siam is so shallow that every part of it is available for fish life which, in turn, is dependent on the abundance of the minute floating animal and plant organisms known as the plankton. The plankton of the gulf and of the waters of the west coast of the peninsula is extremely rich and varied, and this is correlated with the abundance of fish life.

Physical and biological conditions for reproduction and growth appear most favourable for the fishes in the fresh waters of Siam, and have permitted the development of a fauna rich in genera and species. There exists a remarkable profusion of economic fishes, many of excellent flavor and comparing favourably in this respect with the fishes of other tropical countries. The regular occurrence of a protracted period of drought in most parts of the country, with consequent partial or complete drying up of the waters, has led to the development of peculiar anatomical and physiological characters to enable fishes to cope with the untoward conditions.

The elasmobranch fishes known from Siamese waters are numerous, but many forms that are either rare or common undoubtedly remain to be recorded. They fall into two groups, the sharks and the rays and saw-fishes.

The family Galeidae contains many species of sharks that frequent the coasts of Siam, some of large size, some attaining full maturity when only 30 cm. long. A large and fierce spotted shark of the genus *Galeocerdo* is familiar to fishermen in the gulf, but has not been definitely identified. The curious family Sphyrnidae has the head prolonged laterally into conspicuous lobes, with the eyes located at the outer ends of the lobes, whence the common name of hammer-head sharks. These fishes attain a considerable size and produce a large number of young; two species, have been taken in local waters. The whale shark *(Rhinodon)*, sole member

of the family Rhinodontidae, whose center of abundance appears to be Indian Ocean, but which is represented by stragglers from the Pacific and Atlantic Oceans, is not only the largest shark, but the largest fish, and what was probably the largest example ever recorded was caught on the east side of the Gulf of Siam in 1919; it was nearly 20 metres long. The family Orectolobidae has as local members the tiger shark (*Stegostoma tigrinum*), attaining a length of 2 metres, and two species of small spotted sharks of the genus *Chiloscyllium*, with several other species known from Indian and East Indian waters almost certain to be detected.

Rays of various families abound in Siamese waters. The beaked rays (Rhinobatidae) are represented by several species and several others may be looked for. The electric rays (Torpedinidae) of the tropics are much smaller than those of northern waters and the one thus far known from Siam (*Narke dipterygia*) reaches the adult stage when under 20 cm. long. The long-tailed rays that are usually known as sting rays (Dasyatidae), because of the serrated spine or spines with which the tail is armed, constitute the most numerous family as regards both species and individuals. The so-called eagle rays (Myliobatidae) have the head distinct from the body, a long, slender, whip-like tail usually armed with a serrated spine, and the disk much wider than long; the commonest species is *Aëtobatus narinari*. Another recorded form is *Rhinoptera javanica*, representing the cow-nosed rays (Rhinopteridae); while the colossal "sea-devil" or "devil ray" (*Mobula batus*) which has the cephalic fins prolonged into a pair of horn-like appendages and reaches a width of 6 or more meters may be looked for.

The saw-fishes (Pristidae), characterized by the prolongation of the skull into a long, flattered snout whose sides are armed with large, sharp teeth, are found about the coasts and in the sounds, bays, estuaries, and lower parts of rivers. They attain a length of 6 to 8 metres, or even more, and are among the most formidable sea-creatures, as, by lateral strokes of the saw, they are able to inflict frightful wounds; according to reports from India there are cases where bathers have been cut completely

in two by large fish. The species are distinguished from one another by the number of saw teeth, the shape of the saw, the relative position of dorsal and caudal fins, etc. *Pristis perrotteti* and *P. cuspidatus* are common in local waters, and a third species may occur. These fishes are caught on long lines, in traps, and by becoming entangled in nets, and have a market value. The flesh is eaten and the fins in some localities are in higher esteem than shark fins. Chinese joss houses throughout the fishing districts are the repositories of saws that have been presented by fishermen.

The siluroid fishes, or cat-fishes, are numerous as to genera and species, and present a very wide range in form, size, and habits. Eight families are represented in the local fauna by over 20 genera and about 80 species, and additional species will undoubtedly be discovered. The family Clariidae, characterized by very long anal fin, no spine in the dorsal, 4 pairs of barbels, and an accessory branchial organ in an extension of the gill cavity, has 6 fresh-water members belonging to the genus *Clarias*. The Siluridae number about 15 species falling into 6 genera, which include such common forms as *Wallago*, *Belodonichthys*, *Callichrous*, *Kryptopterus* (about 8 species), and the rare *Silurodes*. The family Plotosidae, in which there are a short dorsal fin with a spine followed by a long fin confluent with the caudal and a long anal fin likewise confluent, contains two common fishes of the coastal waters, *Plotosus canius* and *P. anguillaris*. About 13 species belong to the family Pangasiidae, which includes some of the largest and best of the local catfishes of the genus *Pangasius* (10 species), together with *Helicophagus* and *Pseudeutropius*, all distinguished by a short dorsal fin with a pungent spine, a small adipose fin, and a long anal fin. The colossal "pla buk" of the Mekong, reaching a length of 3 meters, is a *Pangasius*. The family Sisoridae has several members belonging in 2 genera: *Glyptosternon siamensis*, a small species peculiar to Siam, known only from the hill streams in Nakon Sritamarat, and distinguished by having on its thorax an organ by means of which it adheres to stones in swift water, and

Bagarius bagarius, widely distributed in the oriental region but uncommon in Siam. The family Ariidae, recognized by the short dorsal fin with a pungent spine, the small adipose fin, the separation of the pair of nostrils on each side by a valve, and various other characters, contains about 20 local species, of which 15 belong in the typical genus *Arius*. These are important food fishes of the coastal waters and the lower reaches of the major rivers, some of them attaining a large size and some, perhaps all, exhibiting the interesting habit of oral incubation, that is, the eggs, large and few in number, are carried in the mouth cavity of the male parent until hatched. The same habit is shown also in *Osteogeneiosus*, a common brackish-water cat-fish. Other local genera of this family are *Ketengus*, a small form with a very wide mouth; *Hemipimelodus*, with 3 species inhabiting fresh water; and the curious *Batrachocephalus*, or frog-headed cat-fish, as yet known only from south-eastern Siam. The Bagridae number about 15 species, of which 10 belong in the genus *Macrones* and are common food fishes of the fresh water; and 5 are in the genera *Bagroides* and *Leiocassis*, small river species conspicuously marked with black and white areas in large pattern. The last family, Amblycipitidae, contains a single species under 12 cm. long, known from India and Burma and from a single locality in central Siam.

The large family of carp-like fishes (Cyprinidae) has many representatives in Siam and is undoubtedly the most numerous and important of the families of fresh-water fishes. About 30 genera and 75 species are thus far known and others will no doubt be recorded. Two other species, the carp (*Cyprinus carpio*) and the gold-fish (*Carassius auratus*), have been introduced from China but are not established in open waters. The genera with the largest number of species are *Puntius* (13), *Dangila* (6), *Cyclocheilichthys* (6), *Osteochilus* (5), and *Rasbora* (7). The family of loaches or cobitids (Cobitidae) contains 6 or 7 species in 4 genera; 2 of them, *Botia modestan* and *B. hymeophysa*, are large enough to be sent to market. The singular family Gyrinocheilidae contains only 2 members, one from Borneo, the other from the interior of Siam.

The world-wide family of herrings (Clupeidae), which contains some of the most abundant and commercially valuable fishes in Asia, Europe, and America, has many representatives in Siam. A large shad (*Hilsa*) runs from the sea into some of the rivers and supports a special fishery in the Menam Chao Phya at Bangkok. The family of round herrings (Dussumieridae) has at least 2 local species, and the family of gizzard shads (Dorosomatidae) has 2 common species. Other families related to the Clupeidae with members in Siam are the Chirocentridae whose single species (*Chirocentrus dorab*) is common in the gulf; the Megalopidae containing *Megalops cyprinoides*, related to the celebrated tarpon of Florida; and the Chanidae, represented by the widely distributed milk-fish (*Chanos chanos*).

The family of anchovies (Engraulidae) is prominent in the seas of Siam, and several species occur in fresh water. The species so far recorded number 14, in 7 genera, and the detection of others known from Burma, Malay Peninsula, and Malay Archipelago may be expected.

Common fishes of the fresh waters are the feather-backs (Notopteridae), of which one species (*Notopterus notopterus*) is essentially a fish of swamps and sluggish waters generally, while another (*N. chitala*), reaching the length of a meter, is a conspicuous fish in the large rivers, where it has the habit of rolling over at the surface and exposing its broad, silvery sides.

To the large, important, and complex family of sea basses (Serranidae) may be assigned *Lates calcarifer*, one of the best and largest of the local spiny-rayed fishes, taken both at sea and in the lower parts of tidal rivers. A strikingly marked species, apparently uncommon in Siamese waters, is *Cromileptes altivelis*, covered with large reddish-brown spots. At least 4 species of *Serranus* are known from the Gulf of Siam, and of the groupers (*Epinephelus*) 10 species are already listed and more may be detected. The beautiful *Plectropoma maculatum*, brilliant red with blue spots, has recently been taken at the head of the gulf

The snappers (Lutianidae), marine bottom fishes, are abundant in suitable localities and 10 species of the type genus *Lutianus*

are thus far known. The genus *Therapon* is represented by 4 species, common shore fishes of small size. The grunts (Pomadasidae) are small marine fishes abundant about shores, and at least 10 species have been listed from Siam; many more doubtless remain to be recorded.

The mackerel family (Scombridae) has some important members, and others may be detected. Among the wide-roaming pelagic species that have been recorded from Siam are several kinds of tunnies. The genus *Cybium*, comprising the so-called Spanish mackerels, has 3 species, excellent food fishes that abound at times in the Gulf of Siam. The most numerous and most important of the local mackerels, however, is the little *Scomber kanagurta*, called "pla tu" by the Siamese.

The Carangidae embrace many species, some of which occur in immense numbers. The typical genus *Caranx* has 12 or more species, mostly small. The genus *Alectis*, with dorsal, anal, and ventral rays produced into long threads, has several species, which are popularly known as thread-fish. The genus *Scomberoides* has 3 or 4 members, one (*S. lysan*) attaining a length of more than a meter.

The drums (Sciaenidae) comprise some species of a meter or more in length and some that reach full size when 12 to 15 cm. long. The larger forms often go in scattered schools of irregular appearance, the smaller ones are always present in greater or less abundance in the coastal waters.

The eels, constituting the order Apodes or footless fishes (in allusion to the absence of ventral fins), are not conspicuous in the Siamese fauna. The eels (Anguillidae) which are so abundant and important in the fresh and salt waters of western and southern Europe and eastern North America are rare in the Gulf of Siam and its tributary rivers, and also on the west coast of Peninsular Siam. The family of snake eels (Ophichthyidae) contains the common fresh-water eel of Siam, *Pisoodonophis boro*, a very slender form reaching the length of a meter and figuring prominently in the markets; and a rarer species (*P. cancrivorus*) as yet known only from the coast of the inner gulf. The family

of conger eels (Congridae) has only two known local species, but other species and genera may be looked for. The morays (Muraenidae) abound in suitable localities about the coasts, and 4 species have so far been recorded. The family Synbranchidae, belonging to a different order from the foregoing eels, has two local members, *Monopterus* and *Symbranchus*, which are fresh-water forms of small size and little food value, able to live out of water for a long time and to withstand the periodical drying up of the sluggish waters in which they occur.

The cosmopolitan tribe of gobies (Gobiidae) is conspicuous for the number of species and for the abundance of some of them in the fresh and salt waters of Siam. There appear to be about 35 genera and 50 species thus far listed. On the extensive mud flats that skirt the shores of the gulf and constitute the banks of the rivers at low tide, mud gobies or walking-fish of the genera *Periophthalmus* and *Periophthalmodon* may always be seen. In the same situations may also be found *Boleophthalmus*. Many small species occur in the canals, streams, and swamps of the interior. The largest of all known gobies is *Oxyeleotris marmoratus*, which attains a length of nearly a meter and is not uncommon in Siam; the closely related *O. siamensis* is found under similar conditions and likewise reaches a large size.

Other families represented in the local fauna by noteworthy species are the pipe-fishes and sea-horses (Syngnathidae), of which a large species of pipe-fish is common in the fresh water of central Siam, while other pipe-fishes and the sea-horse (*Hippocampus*) abound in the gulf; the mullets (Mugilidae), with many species of the type genus *Mugil*; the thread-fins (Polynemidae), characterized by the modification of some of the pectoral rays into free, tactile filaments, with 7 species, several of which attain a length of a meter; the barracudas (Sphyraenidae), of two common species, one small, the other up to 1.5 metres in length; the gars, needle-fishes, and hound-fishes (Belonidae), with a number of species of the world-wide marine genus *Tylosurus*, and a single species of the fresh-water genus *Xenentodon*; the half-beaks (Hemiramphidae), well represented by several marine forms, by the diminutive

fresh-water wrestling-fish (*Dermogenys*), and by the larger fresh-water *Zenarchopterus*, both of the latter viviparous; the flying-fishes (Exocoetidae), of which the commonest form in the gulf is *Cypselurus oligolepis*; the shooting-fishes (Toxotidae), of which *Toxotes jaculator* is a common and highly interesting species in the fresh waters; the fresh-water perch-like fishes (Nandidae), with two species inhabiting swamps and lakes; the mojarras (Gerridae), small marine fishes, with extremely protractile mouth, abundant in coastal waters, of which 4 species are locally known; the Lobotidae, with the widely distributed but not abundant marine flasher *(Lobotes)* and two species of *Datnioides* inhabiting local fresh waters; the pomfrets (Stromateidae), with two well known Siamese species of the genus *Stromateus*; the puffers or swell-fishes (Tetraodontidae), with at least 7 species inhabiting both salt and fresh water. The order of flat fishes, comprising the flounders and soles has a number of local species, mostly marine but several restricted to fresh water.

One of the most important and conspicuous of the families of Siamese fresh-water fishes is the Ophicephalidae, or serpent-head. All belong in the genus Ophicephalus, and 7 species have been recorded, 2 attaining a large size and being valuable market fishes. A special feature of the gill cavity enables these fishes to breathe atmospheric air.

A related family (Anabantidae) contains the celebrated climbing-perch (*Anabas scandens*), one of the most abundant of the lake and pond fishes of Siam. By means of a supplementary breathing organ this fish can use atmospheric air and remain out of the water for protracted periods; and by the aid of the spine in the ventral fins and the spines on the gill covers it can climb banks and low trees, and it is often seen "walking" on dry land between water courses.

This family has 8 other local members, all of them pond or swamp fishes. The celebrated gouramy (*Osphronemus goramy*), the largest of the family, is not common in Siam. The genus *Trichogaster* contains 4 species, of which one is a valued food fish, the others being rather small. In the genus *Helostoma* there is

a single species found in the Malay Archipelago and Malay Peninsula as well as in central Siam. There are two other genera of small fishes, *Ctenops* and *Betta*, the latter having as its known local representative the fighting-fish *Betta splendens*, one of the most beautiful and interesting of all the Siamese fishes.

SNAKES

The snake are a conspicuous feature of the fauna of Siam, although they are much less numerous as to species than in India or the Malay Archipelago and much less a menace to human life than in India. The snakes are now very well known, and it is likely that only a few species remain to be detected. The number of species recorded is approximately 95, in addition to which there are about a score of sea snakes.

At the bottom of the list are the little earth snakes (*Typhlops*), of which seven species are recorded from Siam. They have a worm-like appearance, and live almost entirely below the surface of the earth or under logs or piles of rubbish. The small eyes are covered by shields and probably have little function beyond distinguishing light and darkness.

The largest of the local snakes are the pythons (*Python reticulatus* and *P. molurus*), which elsewhere attain a length of over ten meters but in Siam are much smaller. The reticulated python is common almost everywhere in Siam, and is not infrequently met with in gardens and out-houses in thickly settled communities. Many have been observed in Bangkok where, as in other places the usual length is 3 to 3.6 meters, the largest recorded being 6 meters long. They are nocturnal in habit, and subsist on small mammals and birds, like cats, rats, dogs, ducks, and chickens.

The snakes that are by far the most numerous as to both species and individuals are the colubers (Colubridae), of which the Siamese representatives number 31 genera and about 75 species, exclusive of the sea snakes; all of them are harmless, except the small sub-family of Elapsinae. Among the more noteworthy are the elephant-trunk snake (*Acrochordus javanicus*), with a loose baggy skin covered with small tubercles, reaching a length of 2.5

meters and having an enormous girth ; a fish-eating snake (*Natrix piscator*), very common along water courses and attaining a maximum length of 1.2 meters, and 5 or 6 other members of the same genus ; the so-called rat snake (*Zamenis mucosus*), one of the snakes sometimes eaten, common in most parts of the country and frequently seen about houses, reaching a larger size (up to 2.5 to 3.0 meters) than any other snake, except the python, in the Bangkok region ; the painted tree snake (*Dendrophis pictus*), widely distributed and common, growing to a length of 1.2 meters and having the habit of leaping from one tree to another ; 5 species of *Simotes*, strikingly marked snakes of medium size ; 10 species of fresh-water snakes (*Hypsirhina, Homalopsis, Hipistes, Herpeton*, etc.), of which one (*Herpeton tentaculum*) is uniquely characterized by a pair of long, antennae-like processes protruding from the snout ; the green whip-snake (*Dryophis mycterizans*), an extremely slender, verdant-green species, living in trees and reaching a length of 1.5 meters or more, easily recognized by its sharp snout with a filamentous tip and by the wide gape ; and the black-and-green tree snake (*Chrysopelea ornata*), an active, powerful species, having a length of 1.5 meters, common in Bangkok and other parts of the country. Another interesting snake (*Cylindrophis rufus*), the sole representative of its family in Siam, found under logs and rubbish or in burrows in the earth, has a very short, blunt tail which it is in the habit of erecting among its coils while its head is concealed, giving rise to the name of "two-headed snake" or "snake that bites with both ends" which it bears in Siam, Malaya, and the Dutch East Indies ; it grows to a length of less than one meter and is entirely harmless.

The poisonous land snakes are comparatively few in number of species, and some of them are rare or of very local distribution. There are only 13 species so far recorded, of which 2 are cobras, 3 are coral snakes, 3 are kraits, and 5 are vipers.

The largest and most dangerous is the king cobra (*Naja hannah*), which is found in dense jungle throughout Siam. The usual length of adults is over 3 meters, examples over 4.5 meters

are rare, the largest specimen ever recorded, killed in Nakon Sritamarat in 1924, was 5.5 meters long. The king cobra sometimes attacks people and moves rapidly with its head reared several feet above the ground. Its bite is almost certainly fatal to man, and has been known to kill elephants.

The common cobra (*Naja naja*) is found all over Siam, in jungle, in rice fields, about towns, and even within the limits of large cities, including Bangkok. The average length is about 1.5 meters and the maximum 1.9 meters. This snake is eaten in parts of Siam, and in the Rangsit region, for instance, its numbers have been much reduced in recent years by the demand for food purposes.

The coral snakes are rare and occur in hilly country. The genus *Doliophis*, represented by 2 species, is peculiar in having the poison glands situated, not in the head, as in all other snakes, but at about one-third the length of the body.

The banded krait (*Bungarus fasciatus*) is common in most parts of Siam, and is reputed to be very poisonous, but it is non-aggressive and timid, and cases of human beings bitten by it are rare. The second largest specimen known, measuring 2.9 meters, was killed in the Bangkok Nursing Home. The other two kraits (*B. flaviceps* and *B. candidus*) are known from single specimens from the mountains of Nakon Sritamarat and Sriracha, respectively.

The Siamese variety of Russell's viper (*Vipera russelli siamensis*) is not uncommon in central and eastern Siam, its southern limit being Bangkok. Its maximum length here is 1.3 meters, but it attains a larger size in India. Although this snake is extremely poisonous and in India takes its toll of human lives, in Siam there are few authentic cases of persons having been bitten by it. *Agkistrodon rhodostoma* is a viper allied to the dreaded copperhead or mocassin of North America; it is common in sandy localities in Siam, and is of comparatively small size, never reaching the length of a meter. Of the remaining vipers, all belonging to the genus *Trimeresurus*, one (*T. gramineus*) is the common green pit-viper, attaining a length of less than a

Photo by J. J. McBeth
From Journ. Nat. Hist. Society of Siam.

Cobra (*Naja naja*), with head raised and hood spread ready to strike.

meter, found throughout Siam and frequently met with in gardens in Bangkok, its bite not fatal to man but capable of producing a large swelling and other unpleasant symptoms; one (*T. wagleri*) is a Malayan form whose range extends only into the southern part of Siam; and the remaining species (*T. monticola*) is known from a few specimens from elevated localities in northern and peninsular Siam.

The sea snakes are very numerous throughout the Gulf of Siam, on the west coast of the peninsula, and in the lower reaches of the large rivers. They rarely attain the length of a meter, and may easily be distinguished from other snakes by the laterally compressed tail that is used like an oar in swimming. The local genera number 6 (*Platurus, Hydrus, Hydrophis, Enhydris, Enhydrina,* and *Thalassophis*), and the number of known species is 19, of which 13 belong to the genus *Hydrophis.* Although all the sea snakes are poisonous and their bite is fatal to man, they are of sluggish, non-aggressive habits and fatalities are rare, these being mostly among fishermen who have been careless in handling snakes caught incidently with fish about the shores of the gulf and in the mouths of rivers.

LIZARDS

The lizards of Siam belong in 6 families and about 75 recorded species. They present a wide range in size, form, and habits, and may be found in or about almost every house and garden in Siam, as well as in fields, forests, and jungles.

The gecko family (Geckonidae) contains about 17 known local species, having fragile tails and dilated digits adapted to climbing on smooth surfaces, mostly nocturnal in habits, and feeding largely on insects. In this family is the common house gecko (*Gecko verticillatus*), reaching a length of 30 cm. and found in houses throughout Siam; it has a loud reiterated call, and gets its common names of gecko and tukae therefrom. It feeds on insects and smaller house lizards, and is harmless, although able to administer a severe bite to the person handling it. Two other species of the genus occur but have a circumscribed range. Tree geckos (*Gymnodactylus*) of 5 species are known, and one or more

species of each of the genera *Gonatodes, Phyllodactylus, Lepidodactylus, Mimetozoon* and *Ptychozoon.* The small house geckos, abundant nearly everywhere throughout Siam, are *Hemidactylus frenatus, H. platyurus* and *Gehyra mutilata*; they render a valuable service to human beings by keeping insects in check.

The Agamidae are represented by upward of 20 species in 6 genera, chiefly arboreal. The most striking members of the family are the flying-dragons *(Draco)*, of which 11 species are recorded from Siam. The last ribs are elongated and support a broad wing-like membrane extending along each side by means of which these creatures glide through the air, from tree to tree; when the lizards are at rest, the ribs are closely applied to the sides and the "wings" become inconspicuous. These lizards display beautiful colors, especially on the wings, on the throat, and on a peculiar inflatatable appendage on the throat. Of the other genera *(Gonyocephalus, Calotes, Acanthosaura, Physignathus,* and *Liolepis)*, some of the Calotes lizards have the power of changing their colour like chameleons. *Liolepis belliana* is a beautifully marked common form, reaching a length of half a meter, found in sandy situations and, when angry or excited, inflates its flanks; in some sections it is in demand as food among the country people, and is caught in a snare set over the entrance to its burrow.

The family of monitors or water lizards (Varanidae) contains 4 or 5 local species, called "hia" and "takuat" by the Siamese, common in streams and swampy jungle. At least one species attains a length of 3.5 meters, and its long neck, small head, powerful limbs, and long heavy tail give the impression of some prehistoric lizard as it is seen moving through the jungle.

The skink family (Scincidae) contains about 27 local species, mostly ground-inhabiting, with long, fragile tails. The genera represented are *Lygosoma* (16 species), *Mabuia* (5 species), *Tropidophorus* (5 species), and *Isopachys* (1 species).

The two remaining families of lizards occurring in Siam, namely, Lacertidae and Dibamidae, contain single local representatives. *Tachydromus sexlineatus,* which lives in tall grass in many parts of Siam and has a green back and black-and-white

stripes along the sides, is particularly characterized by a slender, fragile tail that is over four times as long as the head and body, the whole creature being about 35 cm. long. *Dibamus novaeguineae*, known only from the southern part of Peninsular Siam, is a curious worm-like creature, under 20 cm. long with no front limbs and with rudimentary hind limbs developed only in the male, and with rudimentary eyes covered by skin.

FROGS AND TOADS

The frogs and toads are conspicuous elements of the Siamese fauna, both are met with almost everywhere, and the former in particular, at certain times and in certain localities, especially at night and after rains, disclose their presence by auditory evidence which often assumes the character of a continuous, ear-splitting roar. Both frogs and toads perform a valuable service to man by their enormous consumption of insects, and the frogs in turn are eaten by man in limited numbers. The known species of this order in Siam now number about 60 and the list will undoubtedly be greatly extended by collections in the remoter districts.

Of frogs, about 47 species representing 11 genera are already recorded. Some 23 species of the world-wide genus *Rana* have been recorded. The burrowing frogs are known from 4 species belonging to 3 genera (*Callula*, *Calluella*, *Glyphoglossus*). Frogs of the genus *Microhyla*, with to 7 or 8 species, are common and widely distributed.

Toads of the genus *Bufo* represent 4 species; one (*B. melanostictus*) is a very common form in Bangkok. The toad genus *Megalophrys* contains 5 known species mostly found in hills and mountains.

Two caecilians (*Ichthyophis*), wormlike batrachians, blind or nearly so, occur, one being common in Bangkok. They burrow in the earth near water courses and are most active during the rains.

CROCODILES

Two species of crocodiles occur in Siam. One (*Crocodilus porosus*), whose range extends from southern China to India, the Dutch East Indies, Australia, Fiji Islands, and Philippine Islands,

is common in the lower courses of the Siamese rivers and sometimes enters the sea. It attains a length of 10 meters, but in Siam rarely exceeds 6 meters. Its usual food is fish, but it will take almost any kind of animal in the water or on the land, and, notwithstanding the statement* that it "rarely does harm either to man or beast," it is responsible for many human casualties every year. The other species, properly called the Siamese crocodile (*Crocodilus siamensis*), is a smaller inland species, inhabiting rivers, lakes, and swamps, and probably rarely reaching so great a length as 4 meters. It is common in parts of central and peninsular Siam, and is found also in Cambodia and Java. It is non-aggressive and rarely if ever attacks adult persons, but apparently sometime seizes children. It feeds largely on fish, is partial to dogs, and is itself eaten in the country districts.

The gavial or charial (*Tomistoma*), a crocodile characterized by an extremely long and narrow snout, has its chief habitat in the Indo-Australian Archipelago but extends its range to the Malay Peninsula and is known from the Inland Sea near Singora. It is a fresh-water form reaching a length of more than 4 meters.

TURTLES AND TORTOISES

The Siamese representatives of the order Chelonia are a varied group, some of world-wide distribution, some peculiar to the country.

The commonest of the sea turtles is the green turtle (*Chelonia mydas*), which resorts to sandy beaches on the mainland and islands for the purpose of depositing eggs, which, to the number of several hundred, are produced by a single adult. The eggs are in much demand as food delicacies, and the privilege of gathering the eggs on given islands is leased by the government for a stipulated sum each year. These turtles are much less abundant than in former years, and in Siam, as elsewhere, are liable to extermination unless measures are taken for the protection of the eggs. The hawk's-bill turtle (*Chelonia imbricata*), which yields the tortoise-shell of commerce and has a cosmopolitan range, is likewise fairly common in the Gulf of Siam. A species of special

* Graham, W. A., SIAM, 1924, vol. 1. p. 80.

interest is *Batagur baska*, a fresh-water form, which, so far as known, has as its only egg-laying ground in Siam a sandy beach on the inner lake of Tale Sap; it is in imminent danger of extermination. The huge loggerhead turtle (*Caretta caretta*) and the equally huge leather-back turtle (*Dermochelys coriacea*) have been reported from Siamese waters but are too few in number and of too irregular appearance to have any economic importance.

About 15 species of fresh-water and land turtles or tortoises, belonging to 9 genera, are known from Siam. One of the commonest is a soft-shell snapping turtle (*Trionyx cartilagineus*) which reaches a length of 80 cm. and is highly esteemed as food. Of the family of box tortoises (Testudinidae) there are some 12 or 14 species.

BIRDS

The birds are the best known of the warm-blooded animals of Siam, thanks to the studies and collections made by European and American travellers and residents for European, American, and Malayan museums. Many papers on the local avifauna have appeared in the Journal of the Natural History Society of Siam.

Perhaps the most conspicuous bird, taking the country as a whole, is the jungle crow (*Corvus macrorhynchus*), which has a wide distribution and occurs in great abundance in most sections. In Bangkok, there is a large "roost" in Dusit Park. Among other members of the crow family (Corvidae) are various magpies, of which a striking species is the black racket-tailed magpie (*Crypsirhina varians*).

A conspicuous group of birds, some of them to be seen in nearly every community, are the mynas (Sturnidae). They are garrulous, usually occur in small flocks, and some species frequent gardens and houses in the city and country. About a dozen species are now recorded from Siam, of which the commonest are the Chinese myna (*Sturnia sinensis*), the black-necked myna (*Graculipica nigricollis*), the Siamese myna (*Aethiopsar grandis*), the common myna (*Acridotheres tristis*), and the pied myna (*Sturnopastor superciliaris*). These birds habitually asso-

ciate with water buffaloes and other cattle, perching on their backs and eating the ticks with which they may be infested.

The composite family of laughing-thrushes and babblers (Timaliidae) has many members, as has also the related family of bulbuls (Pycnonotidae), noisy creatures frequently seen and heard in gardens, as well as in jungle and thickets.

The flycatchers (Muscicapidae) are small birds of diverse plumage, many with striking combinations of colors. Of the numerous species that occur in Siam, perhaps the most noteworthy is the Burmese paradise flycatcher (*Terpsiphone affinis*) in which the adult male has the two white median tail feathers prolonged to twice the length of the body. Another attractive species is the Javanese fantail flycatcher (*Rhipidura javanica*), a common bird about Bangkok.

The old world family of warblers (Sylviidae) is numerously represented in Siam by reed warblers, willow warblers, wren warblers, grasshopper warblers, fly-catcher warblers, and tailor birds, all of small size. The thrush family (Turdidae) also has many local members, characterized as bush chats, rock thrushes, mountain thrushes, etc. A common and attractive bird in gardens of cities and villages is the magpie robin (*Copsychus saularis*), the male of glossy black and pure white in large pattern.

The drongos or king-crows (Dicruridae) are common and conspicuous birds in most parts of Siam. Among local species are the black, forktail drongo or "king-crow" (*Dicrurus ater*), the larger racket-tail drongo (*Dissemurus paradiseus*), and the hair-crested drongo (*Chibia hottentotta*).

The weaver birds and munias (Ploceidae), of which 4 or 5 species occur, are chiefly noticeable for breeding in colonies and making very large, hanging nests, often in close proximity to houses and usually over water.

The family of broadbills (Eurylaimidae) is sufficiently characterized by its name. The birds inhabit jungle, are arboreal, mainly frugivorous, and most of the local species are highly colored. The most beautiful form is the long-tailed broadbill (*Psarisomus*

dalhousiae), with green back and under parts, blue tail, yellow throat and collar, and black crown surmounted with tufts of yellow and blue. The largest species, the dusky broadbill (*Corydon sumatranus*), is nearly a foot in length, has an extremely broad bill, a whitish throat and breast, and a dull black back with a concealed patch of yellow or orange. Other local members of this family are the black-and-red broadbill (*Cymbirhynchus macrorhynchus*) and the black-and-pink broadbill (*Eurylaimus ochromalus*).

Other families of passerine birds that are more or less prominently represented in Siam are the swallows, wagtails and pipits, larks, shrikes, pittas, orioles, sunbirds, and flowerpeckers. Special mention may be made of the last two families, the Nectariniidae and the Diceidae, which on account of their size, are inconspicuous as seen in the trees, yet for beauty and daintiness vie with the hummingbirds of the western hemisphere. There are over 30 local species, some of them exhibiting gorgeous combinations of iridescent and other colours.

Kingfishers (Alcedinidae) abound on all the water courses, and present a wide range in size and coloration. The largest is the solitary stork-billed kingfisher (*Pelargopsis*), which reaches a length of over 35 cm., while the rare and dainty three-toed kingfishers (*Ceyx*) are only 14 cm. long. More than a dozen other species are recorded, the commonest being the black-and-white or pied, kingfisher (*Ceryle*), the black-capped and the white-throated kingfishers (*Halcyon*), the white-collared kingfisher (*Sauropatis*), and the little Indian kingfisher (*Alcedo*). As their name implies, they feed on fish, which are caught alive, but they eat also insects and crustaceans.

The hornbills (Bucerotidae) are a strongly marked family, with a greatly enlarged spongy beak, surmounted by a helmet or casque, as its characteristic feature. They are mostly birds of dense forest, have loud voices, feed chiefly on fruit, and nest in hollow trees, the female while incubating being shut in by a mass of gum and fed by the male through a narrow opening. The flight is peculiar, and the rush of air through the terminal wing

features produces a rustling sound that carries for long distances. Siam is peculiarly favored in having a large number of species, including both the northern and southern pied hornbills (*Anthracoceros*), the helmeted hornbill (*Rhinoplax*), the wreathed hornbill (*Rhyticeros*), the long-crested hornbill (*Berenicornis*), the bushy-crested hornbill (*Anorrhinus*), and the great hornbill (*Dichoceros*), which reaches a length of 55 inches and is not uncommon in tall timber.

About 10 species of owls (Strigidae) have been observed. A familiar bird is the barn owl (*Strix flammea*), found in Europe, Africa, and America, as well as Asia. Among other species are the eagle owl (*Huhua*), scops owl (*Scops*), pygmy owls (*Glaucidium*), hawk owl (*Ninox*), fish owls (*Ketupa*), and wood owl (*Syrnium*).

Closely allied to the owls in the modern system of classification are the nightjars and goatsuckers (Caprimulgidae), nocturnal in habit like the owls and characterised by fluffy plumage and large eyes, but with weak claws and beak. About 5 species belonging to 3 genera have been detected in Siam, including the great eared nightjar (*Lyncornis*) and the frogmouth (*Batrachostomus*). The local members of the swift family (*Cypselidae*) include palm swifts and cave swifts, the latter (*Collocalia*) being most interesting and having great economic importance because of the edible nests which they make from a salivary secretion. In Siam there are many bird-nest islands containing caves and caverns in which myriads of these swifts attach their frail nests to roof and wall. The privilege of gathering the nests is leased by the government, and an annual revenue of 100,000 ticals is received from this source. The best grade of nests has a wholesale value of 5,000 ticals per picul, or about $15 gold per pound. The giant swift (*Chaetura gigantea*) occurs in high mountains.

The woodpeckers (Picidae) are very numerous as to species and are a prominent feature of the Siamese avifauna, flourishing in the wooded districts in all parts of ths country. There are about 20 recorded genera and 40 species, including a wryneck (*Iynx*) and two piculets (*Sasia*).

The barbets (Capitonidae), characterised by having two toes

in front and two behind, in this respect resembling the woodpeckers, are found in forest and jungle all over Siam, and several species frequent gardens. They are fruit eaters, and many of them have a monotonous metallic note, like the noise made by the hammering of a gold-smith or copper-smith. The commonest form in the Bangkok region is the little *Xantholaema haematocephala*, wellknown to the Siamese as the goldsmith bird (nok ti thawng), which may be heard daily. Other common species are several lineated barbets (*Thereiceryx*), the brown barbet (*Calorhamphus fuliginosus*), several varieties of the blue throated barbet (*Cyanops asiatica*), the gold-whiskered barbet (*Chotorhea chrysopogon*), the many-colored barbet (*Chotorhea rafflesi*), and the great Chinese barbet (*Megalaima virens*), the last inhabiting the forest and jungles of the northern mountains.

A large family, with many conspicuous members, are the cuckoos (Cuculidae). There are over 25 local species falling into 13 genera. One of the characteristic bird notes in Bangkok and other places is that of the Indian koel (*Eudynamis honorata*), with a loud reiterated cry given with a rising cadence and called by the Siamese the "kawao bird" in allusion to its note; another noisy cuckoo is the coucal, or crow-pheasant (*Centropus sinensis*), which is a long-tailed terrestrial species, found in thickets near villages or along roads, and at early morning and at night, usually in a chorus, utters a loud, reiterated "poot."

The Siamese parrots (Psittacidae) include 6 parroquets (*Palaeornis*) and a loriquet (*Loriculus*). Great flocks of noisy parroquets are often met with in the timbered sections.

Birds of prey belonging in the families of hawks and eagles (Falconidae) and vultures (Vulturidae) are very numerous and one or several species are nearly always in evidence about towns, along water courses, over marshes and padi fields, or circling high in the air. Two of the commonest species are the Brahminy kite (*Haliastur indus*) and the pariah kite (*Milvus govinda*). There are various other kites, as well as harriers (*Circus*), hawks (*Accipiter, Poliohierax*), goshawks (*Lophospizias*), shikras (*Astur*), bazas (*Baza*), and falconets (*Microhierax*). The osprey (*Pandion*

haliaetus) is met with in suitable situations. Other noteworthy members of this class are the hawk-eagles (*Spizaetus* and *Lophotriorchis*), the serpent-eagle (*Spilornis*), the buzzard-eagles (*Butastur*), the fishing eagles (*Polioaetus*), and the spotted eagle (*Aquila*). Carrion eaters occurring in the Bangkok region as well as in various other sections are the black vulture (*Otogyps calvus*), the white-backed vulture (*Pseudogyps bengalensis*), and the long-billed vulture (*Gyps tenuirostris*).

The doves and pigeons (Columbidae) are of many species, some common about settlements, others found only in jungle or forest. There are ground doves, ring doves, turtle doves, cuckoo doves, wood pigeons, green pigeons, imperial pigeons, etc.

The family of gallinaceous birds (Phasianidae) has some noteworthy members. The peafowl (*Pavo muticus*) is widely distributed and abundant in some districts. The red junglefowl (*Gallus ferrugineus*) is met with almost everywhere; from it may have come the numerous breeds of domestic fowls. The beautiful argus pheasant (*Argusianus*) occurs in Peninsular Siam. Other striking local species are the firebacked pheasant (*Lophura*), the peacock pheasant (*Polyplectrum*), the silver pheasant (*Gennaeus*), the wood quail (*Rollubus*), the wood partridge (*Caloperdix*), the francolin (*Francolinus*), and the hill partridge (*Tropicoperdix*).

Owing to the abundance of fish, the fish-eating wading birds, herons, bitterns, etc. (Ardeidae), find Siam a favorite place of residence and occur in great profusion of species and individuals. Most noteworthy of these birds are the white cattle egret (*Bubaleus coromandus*), abundant in padi fields and habitually associated with and perching on the back of water buffalo and other cattle; pond herons (*Ardeola*); night herons (*Nycticorax*); little green heron (*Butorides*); common and purple herons (*Ardea*); yellow and chestnut bitterns (*Ardetta*); black bittern (*Dupetor*); and starry bittern (*Botaurus*).

The related family of storks (Ciconiidae) is represented by the white-neck stork (*Dissura*), the black-neck stork (*Xenorhynchus*), the painted stork (*Pseudotantalus*), the adjutant (*Leptoptilus*), and the open-bill (*Anastomus*); while the ibises (Ibididae)

include the white ibis (*Ibis*) and the giant ibis (*Thaumatibis*). All of these birds haunt the shores of ponds, lakes, swamps, and water courses generally, and subsist chiefly on fish and frogs, although the curious open-bill is reported to feed in part on large gastropod molluscs.

The rail family (Rallidae), birds of the marshes and swamps, has some conspicuous local members. Often observed in gardens and common on the edges of water courses is the white-breasted water-hen (*Amauropsis phoenicurus*), while the ruddy crake (*A. fuscus*) also occurs. Other noteworthy species are the water-hen (*Gallicrex cinerea*), the banded crake (*Rallina fasciata*), and the large purple moorhen (*Porphirio poliocephalus*).

Siam's only representative of the crane family (Gruidae) is the stately sarus crane (*Grus sharpi*), with uniform gray plumage and red head, and standing two meters high, which occurs in the central and northern wilds and is often to be seen in a domesticated state in Bangkok gardens.

The family Charadriidae, containing many birds that are wide roamers and for the most part breed in the far north, is represented in Siam by many migrants. Among these are the lapwing (*Sarcogrammus*), the spur-winged plover (*Hoplopterus*), several species of ringed plover (*Aegialites*), the golden plover (*Charadrius*), the avocet sandpiper (*Terekia*), the knot (*Tringa*), numbers of sandpipers (*Totanus*), the curlew (*Numenius*), the godwit (*Limosa*), the fan-tailed and the pin-tailed snipes (*Gallinago*), the painted snipe (*Rostratula*), and the woodcock (*Scolopax*), the last uncommon. Some of these birds afford good sport during the latter part of the rainy season in the padi fields and others on the sea coast.

The family of jacanas (Parridae), with extremely long and slender toes adapted for running on aquatic plants, frequent lakes and swamps. Two local species are the bronze-winged jacana (*Metopodius indicus*) and the pheasant-tailed jacana (*Hydrophasianus chirurgus*), both common in suitable places. In the related family of coursers and pratincoles (Glareolidae), there are two species of swallow-plovers (*Glareola*).

Gulls and terns (Laridae) are common on the coasts and on the lower parts of the larger rivers but are not numerous as to species. Several of them are of world-wide distribution, such as the large Caspian tern (*Hydroprogne caspia*) and the noddy (*Anous stolidus*). There occur locally also the brown-headed gull (*Larus bruneicephalus*), the white-shafted sternlet (*Sterna sinensis*), and three species of marsh terns (*Hydrochelidon*).

The list of water birds includes, among the ducks (*Anatidae*), the whistling teal (*Dendrocycna*), the blue-winged teal (*Querquedula*), the cotton teal (*Nettopus*), the comb duck (*Sarcidiornis*), and other ducks; two species of cormorants (*Phalacrocorax*); the snake-bird (*Plotus*); and a white pelican (*Pelecanus*) which is common on the lakes, swamps, and rivers of the interior.

MAMMALS

The order of Primates has many local members. Among the most noteworthy are the gibbons (*Hylobates*), of which the commonest is the white-handed gibbon (*H. lar*), which exhibits various color phases and is often seen in captivity in Bangkok and elsewhere. The long-tailed monkeys known as langurs (*Presbytis*) belong to about a dozen species, with half a dozen sub-species, and are found all over the country, being abundant in many places. In Southern Siam langurs are trained to gather coconuts. The small monkeys of the genus *Macacus* are numerous and met with everywhere. Of the 10 or more forms already recorded, the crab-eating macaque, the Siamese macaque, the Andamese macaque, and the stump-tailed macaque are the commonest.

An interesting monkey-like creature is the slow loris, or wind-monkey (*Nycticebus tardigradus*), small, tailless, nocturnal, covered with a soft, dense fur, and sometimes carried on native sailing craft because of the popular superstition that it has second-sight and exercises some influence over the wind.

The foremost place among the wild mammals of Siam must be given to the elephant (*Elephas maximus*), of which numerous herds and bands inhabit suitable districts in all parts of the country. The killing of elephants is prohibited by the govern-

Photo by M. H. F. Swete

Wild Hog *(Sus cristatus)*.

ment, and the species seems to be holding its own fairly well, although it is being gradually restricted in its range by the advances of civilization, more particularly through the extension of agriculture. Many hundreds of domesticated elephants are now rendering valuable service to man, especially in the teak forests of Northern Siam where the elephant is indispensable.

Other members of the order Ungulata are the small one-horned rhinoceros (*Rhinoceros sondaicus*) and the two-horned rhinoceros (*R. sumatrensis*), both inhabiting dense jungle remote from settlements and both becoming scarce owing to their pursuit by wild tribes for the sake of their horns and blood, which have a place in the Chinese pharmacopeia. There occurs in Peninsular Siam and in Southern Siam the curious Malayan tapir (*Tapirus indicus*), a large, pied creature, frequenting swamps and nocturnal in habit.

The wild hog (*Sus cristatus*) is common and widely distributed, and the boars often attain a large size and are formidable jungle creatures.

The true deer (Cervidae) have some noteworthy representatives and include the sambar (*Cervus unicolor*), the largest species, which is rather common throughout the country; the brow-antlered or Eld's deer (*Cervus eldi*), generally distributed and not uncommon; the hog deer (*Cervus porcinus*), common in grassy plains in Southeastern Siam and other sections; Schomburgk's deer (*Cervus schomburgki*), peculiar to Siam, of very restricted range, practically unrepresented in museums and zoological gardens, and possibly now extinct; and several species of the muntjac, or barking deer (*Muntiacus*).

Between the hog and deer families are the so-called chevrotains or mouse-deer (*Tragulus*), of which there are two or three species, with many local varieties. They stand less than 45 cm. high, have no horns, and the males develop small tusks. They are common in certain situations, and some of the local races are confined to small islands.

The goat antelope or serow (*Capricornus sumatrensis*) inhabits the mountains and higher hills of Northern, Peninsular,

and other sections of Siam, and several varieties have been recorded. In the mountains of Northern Siam the goral (*Nemorrhaedus griseus*), another goat-like antelope, occurs but appears to be rare.

In addition to a wild race of the domestic water buffalo (*Bos bulalus*) which occurs in various parts of Siam, there are two noteworthy species of wild cattle, the gaur, seladang, Indian bison, or kating (*Bos gaurus*), with a black skin, and the banting, tsaine, or wild ox (*Bos sondaicus*), with a red skin. Both have large horns, live mostly in mountain jungle, and are formidable antagonists at close quarters.

The cat family (Felidae) is headed by the tiger (*Felis tigris*), widely distributed and common in regions where there is ample food with suitable cover. The tiger rarely attacks human beings, but individual animals sometimes develop a fondness for humans and may take a heavy toll in the course of a year. The leopard or panther (*Felis pardus*) is not uncommon throughout the country, even near towns and villages. A melanistic variety called the black panther is not infrequently met with, especially in the south. A number of minor cats abound in various sections, including the golden cat (*Felis temminckii*), the fishing cat (*F. viverrina*), the leopard cat (*F. bengalensis*), and the jungle cat (*F. chaus*).

Domestic cats (*Felis domestica*) of two races peculiar to Siam are very attractive and have become popular among cat fanciers in Europe and America. One variety is characterized by a uniform pale fawn color, with the feet, tips of tail and ears, and muzzle dark brown and the eyes blue. The other variety has a uniform mauve color and yellow eyes. A third form, not restricted to Siam but found over a large part of Southeastern Asia, is of varied colors and always has a peculiar kink at the end of its tail, while the varieties first mentioned have straight tails.

Civet cats of several kinds, characterized by a strong, peculiar odor, are recorded from Siam, among them being the large Indian civet (*Viverra zibetha*), the Burmese civet (*V. megaspila*), the little civet (*Viverricula malaccensis*), and the rare tiger civet (*Linsang maculosus*). Very striking creatures are the palm civets

(*Paradoxurus*), of which several species and varieties are not uncommon and are nuisances because of their destroying poultry and fruit. They have quasi-prehensile tails, and the commonest form has a black-spotted gray fur and a ringed tail.

An otter (*Lutra barang*) ranges over most of Siam and is not uncommon in the central section along the larger rivers and canals. Another species (*L. sumatrana*) has been found a few times in Peninsular Siam. The clawless otter (*Aonyx cinerea*), common in the Malay Peninsula, ranges sparingly as far north as the Inland Sea in Siam. The common otter is very easily tamed and makes an interesting pet.

The list of carnivorous animals inhabiting Siam may be concluded by the mention of the jackal (*Canis aureus*) and the wild dog (*Cyon rutilans*), which go in packs and are widely distributed but do not appear to be numerous anywhere; and two bears, the Malay or honey bear (*Helarctos malayanus*), especially common southward, and the Thibetan bear (*Arcticonus thibetanus*), an inhabitant of the mountainous districts, especially northward. The sloth bear of India (*Melursus ursinus*) has been reported from several Siamese localities but with some doubt.

The insectivorous animals of Siam (Insectivora) comprise the "flying lemur" (*Galeopterus*), a soft-furred arboreal creature reaching a length of a meter, and not uncommon in the southern part of the country; a numerous genus of tree shrews (*Tupaia*), small, arboreal animals having the appearance and habits of squirrels, of which more than a dozen species and subspecies are known from all sections; several genera of ground shrews (*Pachyura, Crocidura*); and a mole (*Parascaptor*).

The bats (Chiroptera) occur in great variety and incredible numbers. There are over 60 known species recorded from Siam. Most conspicuous are the so-called flying-foxes (*Pteropus*), the largest of their tribe in the Old World. There are three or four local species. They live in trees in colonies that sometimes contain thousands, and go forth at night to prey on orchards, in which they may do immense damage; fruit is often protected from their ravages by coverings of cloth or wicker. Various

other genera of frugivorous bats occur, the one with the most species being *Cynopterus*. The local insect-eating bats fall into about 20 genera, of which *Rhinolophus* and *Hipposideros* have the most species. They live in caves, temples, and palm trees, and come forth in the early evening in scattered bodies or solid swarms. By their consumption of insects, they render a valuable service to man.

The rodents, comprising squirrels, hares, rats, mice, porcupines, etc. (Rodentia), are by far the most numerous order of Siamese mammals. Flying squirrels of about 10 species and sub-species, belonging to 4 genera, occur. Other squirrels (*Menetes*, *Ratufa*, *Callosciurus*, *Tamiops*, and other genera), representing over 60 species and varieties, abound in all districts having trees, and several kinds are common in gardens. They have a wide color range, from pure white to pure black, including pale yellow, rich red, and various forms with lateral stripes. The largest squirrel, found in hilly jungle, is 1.2 meters long, including tail, and has a black back and a white belly. A large hare (*Lepus siamensis*) is common over a large part of the country. Rats belonging to the same genus as the common house rat (*Rattus*) are exceedingly numerous, in house, in jungle, on isolated uninhabited islands, and elsewhere. Not less than 50 species and sub-species have so far been recorded. Rats of other genera also are found, including Berdmore's long-tailed rat (*Hapalomys*) and several species of bamboo rats (*Rhizomys*, *Nyctocleptes*, and *Cannomys*). The lists of rodents may be concluded by noting the presence in Siam of 4 species of porcupines belonging in 2 genera (*Acanthion* and *Atherurus*).

The pangolin, or scaly anteater (*Manis javanica*), is a curious burrowing animal with its entire body, short head, and long tail covered by imbricated horny plates by which it is completely protected when it rolls itself into a ball. It is the sole local member of the order of Edentata, or mammals without median cutting teeth. It is eaten in the country districts and its skin is rather extensively exported to China for use in making a medicine.

Of the marine mammals inhabiting the waters in and about

Siam, very little is known. The Cetacea are represented by roving schools of porpoises and dolphins frequently seen in the Gulf of Siam where also small whales are occasionally observed and large ones very rarely; the exact species have not been accurately determined. Many years ago a non-fossilized whale skeleton, subsequently exhibited in Bangkok, was exhumed from paddy field west of the capital at least 25 kilometers from the present border of the Gulf. The sea-cows have, as a local member of the ancient order (Sirenia), the dugong *Halicore* which is not uncommon is estuaries of Southern and Southeastern Siam.

CHAPTER VI

ETHNOLOGY

Very little is known of the first races to inhabit Siam. Polished stone implements have been found in the northern, eastern and southern parts of the kingdom (though not on the great central plain), but it is difficult to fix any date for these implements, and they may belong to a much later period than those found in Europe and Western Asia.

An important find of stone implements was made this year near Ban Na, in Surat Province. The Tarua Tin Company working in that locality turned up a number of these implements, some 12 meters below the surface of the ground, and sent them to the Royal Department of Mines. The find includes two large stone pounders, three polished axe-heads, and two axe-heads shaped, and finely chipped, but not polished. The last are probably unfinished articles.

So far no palaeolithic implements have been found within the confines of present day Siam. However, as no systematic research work has hitherto been undertaken, there may be lying a rich harvest, only awaiting discovery, especially in the caves which abound in the limestone hills in Western and Northern

Photographed by permission of the Royal Department of Mines.

Stone Implements

Found at Ban Na, Surat Province.

Siam. Primitive rock paintings have been found in Eastern and Southern Siam, but it is yet too premature to assign them to any particular race.

Possibly Siam was originally peopled by Negritos, representatives of which are still found to-day in the Semang dwarfs who inhabit parts of the circles of Pattani and Puket. This hypothesis is supported by the fact that Negritos up till quite recently lived as far north as Chaiya, and that the primitive jungle folk called Chawng, living in the remoter parts of the Chantaburi and Prachin Circles, show a marked Negrito strain. Finally it may be added that Negrito skulls have recently been found in a cave situated in Upper Tongking.

The stone implements mentioned above do not, however, belong to the Negrito people, who have not yet reached even the eolithic stage, but still live in the so-called "wood age". The stone implements may be connected with another race, vaguely called the Indonesian, which were the forerunners of the Malays and other Austronesian people, if not identical with them.

In order to understand the composition of the modern population it will be useful to discuss shortly the great racial and tribal movements that have been going on for millenniums in Eastern and Southern Asia. The general direction of these movements have been eastwards and southwards, and even to this day there are relics of this tendency.

While the later movements of the Burmese, Tai (Siamese) and Annamites have followed a north to south line, it seems that the Mon-Khmer people, to-day represented by the Mons, Cambodians and numerous so-called Ka or Moi tribes in French Indo-China, originally came from India. This theory is strongly supported by the philological and anthropological evidence, which shows that the present hill people of Northern India and the Mon-Khmer people belong to the same stock.

The movements or, as they may be called, migration waves, have of course been slow and gradual. These waves would naturally follow the river valleys, as being the easiest march routes and presenting the fewest obstacles, in some cases, however, cir-

cumstances would force the emigrants to cross even formidable mountain ranges.

Thousands of years may have separated the first band of a tribe to move east or south from the last to leave their homeland. Meantime their language and customs have been developing in different directions, so when at last the two bands may come in contact again, they are unintelligible to one another and, at first sight, seem unrelated.

Fortunately in these great migrations, offshoots have been left here and there along the line of march, so that the main routes of the various races or groups still can be traced.

It has been decided, on linguistic grounds, that there may have been four main migration waves, of which the two first, the Austronesian and Mon-Khmer, may have started from a western centre (India), while the two later, the Tibeto-Burman and the Tai, have started from two different northern centres. The terms used, so far, must be regarded as names of language groups, not necessarily of races. It is very probable that some of the people now speaking a language belonging to one of these groups once spoke a quite different one, much or all of their language having been derived from an immigrant or conquering people.

To the four above mentioned migration waves, may now be added two new ones, but how far these have influenced the composition of the present population in Siam is still unknown. Allusion is here made to the recent remarkable discoveries made in caves in Upper Tongking of skulls and part of skeletons belonging to two different races, one of which shows a near relationship to the famed Cro-Magnon of Southern France, i.e., a dolicocephalic or long-headed race, the other showing marked affinities to the Papuans of New Guinea.

It seems that during the pleistocene age these two races co-existed in Upper Tongking and it might well be assumed that at least one of them, the long-headed one, may also have had its habitat in Northern Siam, where a methodical exploration of the caves situated there might one day prove the former existence of that splendid race of men there too.

Among many of the so-called Ka tribes in French Indo-China a long-headed type is met with, which shows affinities with the Dayaks of Borneo and the Battaks of Sumatra.

Of the origin and course of the Austronesian wave but little is known, probably under pressure from the next wave, the Mon-Khmer, it advanced and peopled the islands of the East Indian Archipelago, leaving behind it remnants on the shores of the mainland.

The next wave in point of time was the Mon-Khmer. As stated in the beginning of this paper they may have come from Northern India, possibly driven forward by the Aryans. The Munda languages of Chotia Nagpur in Bihar represent the western end of a chain of languages stretching from Northern India across Further India to the shores of Tongking.

The Tibeto-Burman group, which formed the third wave, probably came down from the eastern part of the Tibetan plateau.

The fourth and last wave was the Tai, a comparatively recent movement. The Tai group was situated in South China, where many millions of Tai speaking people still remain to-day. Researches on the origin of the Tai may prove that they originally came from the west, from a centre somewhere in Western Central Asia, and that they, several thousand years ago, long before the dawn of the Buddhist and Christian era, were in possession of Central China right up to the Hoang Ho.

Coming to historical times it is known that the Mon ruled most of the Menam plain as early as the 7th century A. D., while the Khmer occupied what now is Eastern Siam. There is evidence that before the Mon an earlier people, the Lawa, also of the Mon-Khmer group occupied the land. About the 7th century too, the Tai, who before that time may have been called Ai Lao, founded the Nan-Chao Empire in Yunnan. This empire was finally broken up during the 13th century by the armies of Emperor Kublai Khan.

Long before this time, however, there had been a constant flow of Tai emigrants to Burma and the present Shan States, Northern Siam and Tongking, where they had founded several

important kingdoms. It was, however, not before the middle and end of the 13th century that the Tai conquered Central and Northern Siam respectively from their Khmer and Mon masters.

The Tai thus drove a wedge between the two great branches of the Mon-Khmer group, separating the Mon on the west from the Khmer on the east. Though possibly a part of the original population fled to the hills before the conquerors, the majority no doubt remained where they were and by intermarriage were absorbed by the Tai.

The victors of these conflicts had a habit which adds fresh difficulties to the task of the ethnologist; they frequently took large numbers of prisoners of war and planted them down to colonize a part of the country far away from their original homes. A practice which has been followed up till less than a hundred years ago.

The numerous tribes dispersed throughout Siam, and a considerable portion of the seemingly homogeneous Siamese people, are the final results of these migrations and conflicts. Some of the tribes are now represented by very small communities. The introduction of general conscription, compulsory education and the motor car tend to do away with the peculiarities of language, customs and national dress of these communities, who are being quickly absorbed into the mass of the Tai population.

It is still possible, however, to classify most of them in one or other of the main groups.

On our present knowledge the people of Siam may be classified as follows:—

- Negrito: Semang
- Austronesian: Malay, Chaonam
- Mon-Khmer: Sakai, Lawa, Kamuk or Puteung, Chaobon, Chawng
- Tibeto-Burman: Musso or Lahu, Lawa of Kanburi
- Tai: Siamese or Tai, Tai Korat, Lao (Yuan, Kao, Wieng, Poan, Song)

So
Saek
Kaleung
Ka Brao
Ka Hinhao
Sui or Kui

Khmer
Mon
Annamite

Shan or Ngio
Lu
Putai
Yaw
Yuai
Samsam

Chinese—Chinese

Unclassified: Meo, Yao, Karen, Tin or Ka Tin, Ka Tawng Luang

NEGRITO

Semang

There are now only a few hundred left of this small people, which may formerly have peopled wide tracts in Siam. The Semang Negritos belong to a far flung race of which remnants are found in the Aetas of the Philippines, the dwarf people of New Guinea, the Mincopies of the Andamans and the numerous Pygmy tribes dwelling in the primeval forests of Central Africa. Anthropologically as well as ethnologically speaking, they seem to belong to a very early stage in human evolution, perhaps an anterior one to that of the Australian-Neanderthal man.

The particular clan of the Semang living in Siamese territory is called Tonga or Mos.

The Semang inhabit the mountains of Pattani and Nakon Sritamarat Provinces. A few of them have become tame and work for Malay villagers in return for their food, but most of them prefer a roving life in the forest.

These people are of a dark rufous-chocolate in colour and small in stature, the men averaging about 1.5 metres in height, and women somewhat less. Their hair is a short, closely curled, wool. The lips are not particularly thick and the face is not markedly prognathous.

The men used to wear a T-bandage of bark cloth round the loins, the loose ends hanging down in front, while the women had a short skirt made of grass or vegetable fibre. Nowadays they usually wear cotton garments, more or less like their neighbours of the nearest settled villages.

They do not build themselves permanent houses, but simply shelters made of leafy branches, stuck in the ground and bent over at the top. No form of cultivation is practised. For vegetable food the Semang depends on wild fruit and roots, while animal food he gets by the chase. His principle weapon is the blow-pipe, which is, apparently, not original with him. The blow-pipe darts are sometimes poisoned, the poisons chiefly used being the juice of the upas tree *(Antiaris toxicaria)*, and the scrapings from the bark of a species of *Strychnos*.

AUSTRONESIAN

Malay

There are about 400,000 Malays living in Siamese territory, most of them in the southern provinces.

The modern Malay is of very mixed race; but it seems fairly certain that his main derivation is from the Jakuns, or Proto-Malays, a primitive jungle tribe scattered through the Peninsula and related to the Chams of Annam.

According to some students and other keen observers the Pattani Malays are also strongly mixed with Semang, the original inhabitants of this part of the country.

The Malays in Siam are all Mohammadans, but are much less strict in the observances of the tenets of their religion than most other Mohammadan races. The women, for instance, usually go about unveiled. The Pattani Malays were formerly for many generations ruled by queens, which may point to the matriarchate having existed among them, as it still does to-day among the Battaks of Sumatra.

In Siam the Malay cultivates rice in much the same way as the Siamese. He is also a good fisherman and a number of them make their living in that way. He is more willing than most of his neighbours to make deep-sea voyages.

Chaonam

The Chaonam, or Chaolé (Seamen), called in Malay Orang-Laut, in Burmese Seleung, and by themselves Mawken, are a primitive people, making their living, as some of their names imply, by the sea. In former days they lived chiefly in their boats, only occasionally camping on the shore in temporary shelters. In comparatively recent years many of them have taken to more or less permanent villages on the seashore. There are still numbers, however, who move about from place to place. The shelters of these migrants are formed of palm leaves, stitched together in long strips, and bamboo poles. When a move is made the palm-leaf strips are rolled up and, together with the poles, packed on the boats.

Their main-headquarters is the Mergui Archipelago, but they are found here and there all along the west coast of the peninsula, right down to Singapore. In Siam they frequent many of the islands off the west coast.

They have a distinct language of their own, but it is rapidly dying out. It is, however, still spoken in parts of the Mergui Archipelago, where records of it have been made. It is said to be related to Cham.

Those met with in Siam all seem to speak Malay, sometimes in a very corrupt form. Besides drying and salting fish, they prepare trepang and dive for pearl-oysters, pearl-shell and other marine products. They are adept divers, and, it is said, can go down to a depth of 16 or 17 fathoms.

Their boats used to be of rather peculiar construction; the lower part being formed of a dug-out, or hollowed tree-trunk, while the sides were built up with the leaf-stalks of the rakam palm (*Zalacca Wallichiana*). This formed a very light, but rather fragile structure. At the present time rakam boats are rarely to be seen, most of their boats being now built entirely of wood.

The Chaonam may be regarded as the maritime branch of the Jakun or Proto-Malays.

MON-KHMER

Sakai

Some few of these people were formerly said to live in the

mountains of the Pattani Circle, but, according to recent researches, it seems doubtful whether there really are any of them left to-day. Possibly there never were any Sakais in the present Siamese territory. The belief in their existence there may be due to the Malays who, in their curious ignorance of the primitive people living so near to them, mistakenly call the Semang pygmies Sakai.

Lawa

According to historical evidence recently acquired, there can be no doubt that most of Northern Siam, the present circle of Payap, was formerly peopled by the Lawa, who even reached as far south as the towns of Raheng and Kampengpet on the Ping River. The Lawa were conquered in the 7th century A. D. by Mon colonists from Lopburi, who founded the cities of Nakon Lampun and Nakon Lampang, and who intermarried to a great extent with the Lawa. The Lawa may be considered as rather rough country cousins of the Mon.

From their old deserted fortified towns and their tombs which abound, especially in the Muang Yuam district to the west of Chiengmai, as well as from what is told in the Northern Chronicles, the Lawa formerly possessed a far from mean culture, and were sometimes governed by mighty kings, who headed big armies with war elephants, against the invading Mon.

These Lawa live chiefly on a large plateau to the southwest of Chiengmai, between Muang Hawt and Muang Yuam, where they have a number of scattered villages. It is said that many of the people of the villages on the adjacent plain are also of Lawa descent, though now indistinguishable in speech and dress from their Lao neighbours. If, as seems probable, the Lawa occupied the country before the Lao, the admixture of Lawa with Lao is much more widespread than this.

Though there is a fairly large infusion of Lao blood in the Lawa, many of them can still be distinguished by their darker complexion and shorter stature.

The language of the Chiengmai Lawa is closely related to that of the Wa of Burma and, no doubt, they were both originally of the same stock.

The Lawa living on the plateau have, to a large extent, adopted the dress and costumes of their Lao or Karen neighbours. Unlike the Lao, however, the women are fond of wearing silver bracelets and necklets. They live in substantial houses raised on piles, often with walls of sawn pine-planks. Their houses have fenced-in compounds, where fruit and vegetables are grown.

The chief industry of these villages is smelting iron, from ore found in the neighbourhood. The iron so obtained is wrought into spades, knives and chains.

Some cultivation is still carried on in temporary forest clearings, but many of the villages now possess permanent rice fields.

Kamuk

This race has its headquarters to the east of the Mekong, in the Luang Prabang district. Numbers of them come over every year to work in the teak forests and some of them settle in the country.

In the north of Kanburi Province there are a few Kamuk villages. These people say they originally come from the Luang Prabang district, but it is not unlikely they were brought as prisoners of war. Some of them still speak their own language, but in dress and customs they conform to their neighbours. There are also a few Kamuk villages in the northern part of Nan Province.

The Kamuk are also found in Northeastern Siam, as for instance, in the district of Chaiburi at Keng Sadok (Mekong River) in the circle of Udorn and in the town of Ubon. They are not indigenous there, but were originally brought to these places by Burmese slave traders about half a century ago. These Kamuks, or as they also are called Puteung, hail from the left bank of the Mekong (district of Kammon) and, having been liberated by Roman Catholic Missionaries, are now all Christians. The Puteung community in Ubon, about 300 souls, have adopted Tai or Lao Kao as their language, their original language being quite forgotten.

Chawng

The Chawng are found along the foot of the mountains in

Chantaburi Province. They also extend into Cambodia, which may be regarded as their headquarters.

Though the Siamese call them Chawng, the Cambodians call them Porr; they give themselves the name of Tamret or Samrae. Their language is distinctly related to Khmer. In dress and customs they now approach very closely their Siamese neighbours.

The late Dr. Jean Brengues took a series of measurements and showed that the Chawng differed from the Khmer in several particulars, amongst others that they were, on the average, mesaticephalic, while the Khmer are sub-brachycephalic. He also found, as pointed out in the beginning of this paper, that there is a marked Negrito strain in about 20% of the Chawng, which probably is due to their having absorbed a former Negrito population living in the Chantaburi Circle.

The Chawng are no doubt nearly related to the Sui or Kui people of Northeastern Siam, which are identical with the Porr, Samrae or Kon Cho of Cambodia.

The Chawng cultivate most of the cardamoms for which Chantabun is famous. They have some permanent rice fields, but also grow rice in forest clearings.

Chaobon, or Lawa of Petchabun and Korat

These people live in a few villages in two rather widely separated groups: one is to the southeast of Korat, the other to the northeast of Petchabun. The Lawa population of Petchabun may formerly have stretched as far westwards as Lopburi, whose ancient name was Lavapura.

They are called by their neighbours Chaobon, their official designation is Lawa, while they call themselves, in the Korat district at least, Nia-Kuol.

Not many years ago the Chaobon lived in the forests, cultivating clearings and moving from place to place as the forest was used up. They were not regularly taxed, but paid tribute in the form of jungle-produce, such as black-lacquer varnish (naman rak) or scented woods (kawn dawk). Now they nearly all live in permanent villages.

The language of the Chaobon shows affinities to both Mon

and Khmer. It is not, however, nearly related to that of the Chiengmai Lawa.

Both men and women now wear Siamese costume, but some of the women still occasionally wear, in addition, a long piece of cotton cloth wrapped several times round the waist and tied in a knot over the right hip.

The Chaobon are being rapidly absorbed into the surrounding population and only the older people speak the language.

So

The So are a very dark skinned race, their colour sometimes nearing black; their speech resembles much the Khmer. They originally came from the left bank of the Mekong (district of Kammon). The So living in Siamese territory are mostly domiciled between the large fresh-water lake of Nong Han Sakol, and Nakon Panom, other groups live on the banks of Nam Songkram and on the northern slopes of the Pu Pan range. About 20 years ago the So numbered about 10,000 individuals. Though now all Buddhist they are very superstitious, especially fearing the evil eye (Pi bob). The So dress like the Lao people, but their young women add to their costume a gaudy silk scarf wrapped round their chignon. They till the fields and keep cattle as the Lao do.

Saek

The Saek form two small communities; a bigger living in Asamart to the north of Nakon Panom, and a smaller one in the district of Ta Utaen. Twenty years ago they numbered only 600 individuals. The Saek came also originally from the left bank of the Mekong. They are a picturesque people. Their young women are noteworthy for their queer round dances and—their dubious morality. With regard to their manner of livelihood and dwellings the Saek resemble the Lao.

Philologically speaking, the Saek undoubtedly belong to the Mon-Khmer group, but their language is much mixed with Lao.

Kaleung

These people were deported from their original home on the left bank of the Mekong to the present provinces of Nakon Panom and Sakol Nakon nearly 90 years ago, with the result that they

now all have forgotten their mother tongue and talk Lao only. About 30,000 individuals still call themselves Kaleung, most of them living on the forest clad slopes of the Pu Pan range south of the town of Sakol Nakon. To the not very keen observer they are now indistinguishable from the Lao.

Ka Brao

These people have come over from the left bank of the Mekong river and form several small communities in the sub-district of Chanuman, Kemmarat District, Ubon Province. They cultivate the ground like the Lao and build their houses in the Lao style, but still cling to their own language. Their original home is in the district of Attapeu. The Lao call them Ka Lovae, though their correct name is Brao. The number domiciled in Siamese territory is about 500 individuals. Up till a few years ago there lived in a few villages south of the town of Korat some people called *Ka Tang Ong*. These people were originally prisoners of war, and also belonged to the Brao tribe. They have now been completely absorbed by the surrounding Tai.

Ka Hinhao

To the south of the mouth of the Mun River, where it falls into the Mekong, there lives a small community of Ka Hinhao which quite recently has crossed over from French territory. Like the Brao they belong to the wide spread Ka race.

They cultivate forest clearings and live by hunting and collecting edible roots and forest fruits.

Sui or Kui

The Sui, or to call them by their proper name Kui, i. e. men, the first being a Siamese name meaning tributary people, are an important race peopling large tracts of the provinces of Surin, Kukan and Ubon, even spreading into the province of Roi Et. The Kui are closely related to the Khmer and may indeed be considered to be their near cousins, though there is a considerable difference between their respective languages. As far as can be ascertained the Kui represent the original population of Cambodia and of the whole of Eastern and Northeastern Siam. As a matter of fact a considerable part of the so-called Lao in these regions are only Tai-

speaking Kui. Besides a numerous population of Kui, still speaking their own language, there are large numbers of so-called Lao-Sui and Khmer-Sui, the first named peopling large tracts in the provinces of Ubon, Kukan and Surin, while the latter are mostly domiciled in the province of Surin. The Lao-Sui and Khmer-Sui are Kui people who are in the process of changing their own language for that of Lao and Khmer respectively. The Kui people are at a much lower stage of culture than the Lao and Khmer and, though officially Buddhists, they may be considered as animists *par excellence*. They till the fields and keep cattle like their Lao and Khmer neighbours, but their houses are badly built and very dirty. The Kui are divided into a number of clans or septs, of which the M'lo and M'loa clans are the biggest, while the clan of the Kui M'ai is known for their bold and clever elephant hunters. About twelve years ago the total Kui-speaking population of Northeastern Siam numbered about 120,000 souls, besides 144,000 Lao and Khmer Sui. The Kui are a rather dark skinned race, though not so dark as the So, in some of them certain negroid traits appear, such as curly hair. There is, however, considerable difference between the various clans, and the comely light skinned Lao-Sui girls of Srisaket are very attractive.

Khmer or Cambodians

The Khmer live in the provinces of Buriram, Surin, Kukan Ubon, Roi Et and Krabin, besides Krat. A few communities originally prisoners of war, are found in the provinces of Ratburi and Kanburi.

The Khmer and the Siamese are naturally much alike, though the Khmer generally are of a somewhat darker complexion and grow more hair on their faces. As regards manner of livelihood, religion, customs and dress, they differ little from their Tai or Lao neighbours, but, unlike the Sui, they still stick to their own language. The total number of Khmer in Siamese territory cannot be much less than 160,000 individuals.

Mon

As stated in the beginning of this chapter, the Menam plain and large tracts of North Siam were peopled by Mon prior to the

Tai conquest. The present Mon population is, however, not descended from these original Mon, who seem to have been completely absorbed by the conquering Tai, but descended either from prisoners of war, or from refugees who fled to Siam to escape Burmese oppression. There have been several large migrations of Mon from Burma, their original home, to Siam; namely in 1600, 1660, 1774 and finally in 1814. The Mon are, on the average, somewhat taller than the Siamese, whom they resemble closely. Their dress is like that of the Siamese, but their women, who often are very pretty, usually wear their hair long. All Mon can speak Siamese, but many of them still use their own language. The number of Mon domiciled in Siam has been put as high as 60,000 individuals. The largest communities live near Bangkok in localities such as Paklat, Pakret, Samkok, besides Ayudhya, Lopburi, Nakon Sawan (Uthaithani), Ban Pong in Ratburi Province, and in the Kanburi Province scattered along the valley of the Kwae Noi up to the Burmese boundary.. To the south of Korat, in the districts of Pak Tong Chai and Kratok, live about 2,600 Mon scattered in several villages. These Mon have, however, completely forgotten their mother tongue and now dress and behave just as their Tai Korat neighbours.

Annamites

The Annamites were formerly placed in the Mon-Khmer group, as their language contains a certain number of words belonging to that language group. Recent researches seem, however, to show that the Annamites belong to the Tai group, and that mixture with the Muong, a Mon-Khmer people living in Lower Tongking, as well as with the Chams and Cambodians and, last but not least, Chinese during 600 years, has produced the present Annamite type and language.

About 6,000 Annamites are settled in Lower Siam, chiefly in the circle of Chantaburi. Most of these are descendants of Christians who fled from Annam to escape persecution some 80 years ago. These people still keep apart and dress in their national black costumes of loose trousers and long coats; they also speak

their own language.

In Northeastern Siam are found several large Annamite colonies: in Nongkai, Nakon Panom and Sakol Nakon, besides smaller communities on the banks of the Mekong, altogether numbering several thousand individuals. It seems that the Mekong valley is attracting more and more Annamite emigrants, who are more energetic and virile than the somewhat indolent Lao population.

TIBETO-BURMAN

Mussô

Not many Tibeto-Burman races inhabit Siam. The Kaw or Ahka, originally living near the border of the Shan States to the west of Chieng Sen, have since trekked to the hills north of Phrae, where they live in a large well built village. These Kaw are very nearly related to the Mussô, and are in fact a branch of that great tribe.

The Mussô seem to be one of those races that still show a tendency to move southwards. They are to be found on many of the high mountains of Northern Siam, reaching as far south as Lat. 17° 30′, on the hills to the west of the Me Ping in Chiengmai Province. In their mode of life they much resemble the Meo and the Yao, described later.

In Siam two tribes are recognized: the Mussô La or Mussô Dam (black Mussô) and the Mussô Le or Mussô Deng (Red Mussô). The chief distinction between these two tribes seems to be that the women of the Black Mussô wear dark blue trousers, striped with red at the bottom, while those of the Red Mussô wear a *sin* striped with red. The dress of both men and women is somewhat like that of the Yao, but the long coat of the woman is not slit so far up the sides, and it is adorned with red stripes on the sleeves and along the edges, not with the red frill of the Yao. Nor do the women embroider their trousers in the elaborate way the Yao do. They use large, round silver clasps for the coat. The silver neck-ring, without a plaque, seems to be worn by the women only.

Lawa of Kanburi

Scattered over the northern part of the Kanburi Province

are a number of villages inhabited by a people designated Lawa. They are now fast becoming absorbed into the surrounding population and show but little difference from their neighbours in custom or dress.

A number of these people, however, still speak their own language, which has no resemblance to that of the Chiengmai Lawa, nor does it resemble the language of the Chaobon, who are also sometimes called Lawa. On the other hand it shows distinct affinities with the Tibeto-Burman group of languages. At present, however, too little is known about them to enable them to be definitely connected with any of the Tibeto-Burman races; their place here must be regard as provisional.

It is said that many of the villages along the Me Klawng and Kwe Noi are inhabited by people of Lawa descent, though they are now indistinguishable from Siamese.

TAI

It has already been mentioned that the original home of the Tai was probably in Southwestern China and that many Tai speaking people still remained there. In addition, members of the Tai race are to be found as far east as Tonkin and Hainan, and as far west as Assam. In Assam they are represented by the Ahom, who have now become nearly completely Hinduized, but remnants of the language are retained by the priestly class. Some authorities hold that the Cantonese is really of Tai descent, though he is now Chinese in all his ways. Elsewhere, however, the Tai have preserved their language in a wonderful way; it is said that a Siamese from Bangkok can make himself understood, with but little difficulty, in the upper valley of the Yang-tze.

As will be understood from what has been said in the preceding the Tai race is a great and far flung race, and is not at all contained within the confines of the present Kingdom of Siam. Altogether the Tai race must number not less than 18 millions, of which only 9 millions are domiciled in Siam; the remainder living in China, French Indo-China and the Shan States.

Siamese

Little need be said about the Siamese here, as they are

dealt with in the companion volumes.

No doubt in their progress from their northern home the Tai have mixed with the people they found occupying the land before them. In this way they have received considerable infusion of Mon and Khmer blood, and more recently of Chinese. The result is the modern Siamese as seen in Bangkok to-day.

The Siamese call themselves Tai, and by those talking the Siamese language or King's Siamese is generally understood the population living between the towns of Utaradit in the north and Petchaburi in the south and from Kanburi in the west to Saraburi in the east, i. e. the so-called seven Inner Circles. The population south of Petchaburi, peopling Siamese Malaya, speaks a peculiar dialect, a sort of "clipped" tongue, called "pasa chao talae". The Southern Tai are much mixed with Lao prisoners of war from Lampun, brought down here 400 years ago, as well as with Malays and Chinese.

Tai Korat

The Tai Korat people most of the province of Korat or Nakon Rajasima. They talk Siamese with a curious singing intonation and rather uncouthly. The Tai Korat, a sturdy and brave people, are probably the outcome of a mixture of Tai warriors from the time of Ramathibodi I (middle of 14th century) and Khmer women, at the time when the young Kingdom of Ayudhya wrested the western part of the present Korat circle from the Khmer.

Lao

The Lao differ but little from the Siamese, and are in reality as much Tai as are the Siamese. The Lao do not call themselves Lao but Tai; the name Lao having been bestowed on them by the Siamese and may be due to the fact that the Lao occupied land formerly peopled by Lawa. Their language has some dialectial variations and contains fewer imported Sanscrit and Pali words than Siamese.

The Lao of Siam are divided into two divisions; the Lao of Northern Siam or Lao Pung Dam, and the Lao of Eastern Siam, or Lao Pung Kao. Lao Pung Dam and Lao Pung Kao respectively mean Black-bellied Lao and White bellied Lao. The name Black-

bellied refers to the fact that the men of the Northern Lao are closely tattooed from the waist line to the middle of the thighs, this tattooing is absent in the White-bellied Laos.

The Northern Lao inhabit the whole of Northern Siam and extend as far south as the Nakawn Sawan Circle. In addition to the name Lao Pung Dam they are frequently called by their neighbours Lao Yuen or Tai Yuen. The Eastern Lao occupy a great part of the Korat Plateau and the valley of the Mekong. There are also scattered communities of both these Lao divisions in Lower Siam, particularly in the Provinces of Ratburi, Petchaburi, Prachin and Saraburi.

The Eastern Lao can be divided into two language groups: the Lao Wiengchan and the Lao Kao. The first group occupies the western part of Udorn circle and the provinces of Chaiyapum and part of Nakon Rajasima in the circle of Nakon Rajasima and it forms a considerable part of the population in the former circle of Roi Et, with many strong settlements in the provinces of Ubon and Kukan.

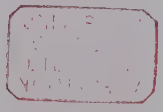
The second group forms an important part of the population of Eastern Udorn and the former circle of Roi Et, while in the former circle of Ubon about 50% of the population are Lao Kao. In the circle of Prachin most of the population in the three provinces of Prachin, Krabin and Nakon Nayok are Lao Wiengchan, all originally prisoners of war deported to these districts just one hundred years ago.

The dialectic difference between Lao Wiengchan and Lao Kao is not great, but quite distinct to an observant ear. In the circle of Udorn and in Changvad Roi Et are found a few settlements of *Lao Poan*, a Tai people living on the plateau of Chieng Kwang, to the north of Wiengchan, who formery formed an independant Kingdom. The Lao Poan talk a dialect slightly different from Lao Wiengchan, and are more light complexioned than the latter.

Finally there may be mentioned the *Lao Song* of which scattered settlements are found at Petchaburi, Ratburi, in the circle of Nakon Chaisri and at Pichit in the circle of Pitsanuloke. The Lao Song are a Tai tribe whose original home was on the plateau

Photo by M. H. F. Swete

Shans, Northern Siam.



to the east of Luang Prabang, from where they were brought down as prisoners of war to Siam about 90 years ago. Their women dress in a kind of black skirt, or pasin, with white vertical stripes, and wear tight-fitting sombre-dyed blouses with silver buttons. They speak a dialect resembling Putai.

Shan or Ngio

In Siam the Shans, or, as they are called in Siamese, Ngio, are chiefly to be found along the northwestern border, within the Salween drainage area.

The Shan usually calls himself Tai Yai, or Great Tai, in contradistinction to the Siamese and Lao whom he calls Tai Noi, or little Tai. Their language does not differ greatly from Siamese or Lao.

The women dress very much like the Lao, but the men affect very baggy black trousers, a loose white coat and turban. When they go on a journey they wear over the turban a hat with a very broad brim.

The Shan is a great trader and many be met with peddling his goods in many parts of Siam.

Lu

The main part of the Lu live to the east of the Mekong, but many of them are settled on this side, chiefly in the Nan Province.

In their language and customs they resemble the Lao. Most of them, too, dress like the Lao, though at one time they had a a distinctive dress of their own. In the women this consisted of a red chemise with a black coat over it, and a sin striped in red, white and black. The men wore wide, dark blue trousers and short coats.

The Kôn (Kurn) or Hkun, a people found chiefly in the State of Keng Tung, but extending into Chiengrai Province, seem to be only a branch of the Lu.

Putai

The *Putai* on the Siamese side of the Mekong are quite a large community, numbering roughly 70,000 individuals, but the bulk of this branch of the Tai race lives on the left bank of the great river. They have many large well built villages in Eastern Udorn,

in the provinces of Kalasin and Ubon. Their particular dialect much resembles Shan. Their dress also differs from that of the Lao in that the women, who are often very white skinned, wear a kind of turban. The Putai in Siam, though all nominally Buddhists, are very much addicted to spirit and ancestor worship.

Yaw

Other Lao tribes living in Siamese territory are the Yaw, who are mostly domiciled in Eastern Udorn, round the town of Sakol Nakon and to the north of Nakon Panom. They hail from the left bank of the Mekong and dress like the Lao, whose language they speak with a peculiar harsh sound.

Yuai

The Yuai is another Lao or Tai tribe whose original home also was on the left bank of the Mekong. They dress like the Lao, but talk their language with a queer sing-song intonation. Their women are known for their skilful embroideries. The Yuai live round Akat Amnuei to the northwest of Nakon Panom.

Sam-Sam

There are a small number of these people, apparently of mixed Siamese and Malay descent, living in the western coast districts of Southern Siam. They are Mohammedans.

CHINESE

Chinese

The number of Chinese in Siam is officially given us 445,274. Most of these are living in the larger towns, in fishing villages along the coast, or in mining districts.

The influx of Chinese into Siam has been going on for several centuries. Up to about twenty years ago Chinese men only came, they married Siamese women and their progeny was gradually absorbed into the general population. In recent years, however, the Chinese have brought their wives with them, or sent to China for them, and they show a tendency to form closed communities.

UNCLASSIFIED

Meo

This is a tribe of hill people called by the Chinese Miao-tza and by themselves Mong. Meo is the name they go by in Siam.

They are to be found here and there on the mountains of Northern Siam; coming as far south as about Lat. 17°, on the range to the northeast of Petchabun. They are also widely spread through Southwestern China.

Some authorities have grouped the Meo with the Mon which, however, can only be a provisional classification. Other students consider the Meo as pure Mongols, pointing out that their language shows a striking similarity to the Kwan Hua or Mandarin language of China. It is a well known historical fact that the Meo for many centuries formed a strong and well organized kingdom in the present province of Kweichow. Their advance southwards is of fairly recent origin and due to Chinese oppression.

The Meo are divided into several tribes, chiefly distinguished from each other by the dress of their women. The two tribes most often met with in Siam are called the Meo Kao, or White Meo, and the Meo Lai, or Striped Meo. In both tribes the dress of the men is the same; they wear loose dark blue trousers, a short coat of the same material and either a turban or a close-fitting skull cap, both also dark blue, but the turban sometimes ornamented with a red top-knot and the cap with a red button. The trousers are held up by a waist band, often with red embroidered ends.

The dress of white Meo women is peculiar and distinctive; it consists of a short, pleated, grey skirt, coming about to the knees, and the coat in front being produced into long tails, which may be tied round the waist. Over the skirt is sometimes worn a short, dark blue, apron. Their head-gear, when in full dress, is a large turban made of folds of blue and grey cloth.

Both men and women wear silver neck-rings, to which are attached silver plaques bearing an inscription in Chinese character. As a rule, in Siam at least, the Meo are unable to read the characters on these plaques; when a new one has to be made an old one is faithfully copied. The women sometimes also wear silver hooks, attached to the turban above and the ear below.

The Striped Meo women differ in wearing a sin, or long, rather narrow, straight skirt, with a black and red pattern,

instead of the short pleated skirt.

The hill tribes of Siam live in more or less self-contained communities, able to supply nearly all their own wants. There are usually, however, a few things, like salt, which they must obtain elsewhere. The Meo way of living is similiar to that of most other hill tribes, so what is said here also applies to those, unless stated otherwise.

The houses of the Meo are usually built of split trunks placed vertically, the floor being formed by the ground, though there is a raised sleeping platform along one side. The roof is generally thatched with palm leaves. Neither the individual houses nor the villages as a whole are fenced in.

Like all hill tribes, except the very wildest, who do not cultivate at all, the Meo plant their rice in forest clearings. In addition to rice they grow sweet-potatoes, gourds, Indian corn, chillies, radishes, hemp, (*Cannabis sativa*), from which they weave a coarse cloth, a plant yielding a dark blue dye (*Strobilanthes flacidifolius*), tobacco and sometimes opium.

Each year fresh clearings have to be made, so in course of time, usually 12-15 years, all the forest in the vicinity of the villages has been used up. Sooner or later the Meo finds it necessary to move his village. The whole band then migrates to another mountain, often at a long distance off. As they take with them all their utensils and all their animals, pigs, poultry, dogs and ponies, not to mention children of all ages, these migrations are a slow business and may extend over two or three months. In those months, however, a distance of upwards of fifty miles may be traversed before a suitable mountain is found.

Yao

The headquarters of the Yao are also in Southwestern China, chiefly in the province of Kuang-Hsi.

In Siam the Yao are most abundant on the mountains of Nan Province. Their habits and villages are very similar to those of the Meo. Like the Meo, too, they are divided into a number of tribes.

Both men and women dress in dark blue. The dress of the

Yao, Nan Province.

Note the embroidery on the women's trousers, her coat is tucked up to display it, also the neck ring and the series of silver clasps fastening the coat.

men is very like that described for the Meo. The woman wear a short coat and trousers, the latter elaborately embroidered with red cotton; over all is worn a long coat, slit up the sides to the waist, and with its front edges trimmed with red cotton fluffed out like fur. This coat, in full dress, is fastened by a series of oblong, silver clasps, reaching from the neck to the waist. A dark blue turban with a red top-knot finishes off the costume.

The women spend much of their spare time embroidering; they walk about the village with their embroidery in their hands, going on with it whenever they stop to talk to a friend.

Karen

Karens are fairly numerous in Siam, the number being estimated at 60,000.

A great part of the Karen country lies outside Siam, in the Southern Shan States and Lower Burma, but it also extends over the border, chiefly along the hills of the western boundary, from the provinces of Me Hawng Sawn and Chiengrai in the north to the province of Petchaburi in the south. The Karen also extend eastward into the province of Lampun.

The position of the Karens among the other races of Indo-China has been something of a puzzle; it has been suggested that their speech is more allied to that of Tai than to any of the Mon-Khmer or Tibeto-Burman languages. If this is so their connection with the Tai must have been very far back.

Karens are usually divided into three main branches, known as the Sgaw, Pwo and Bghai. There is a reason to think that all three branches are represented in Siam.

To the Bghai belong the Red Karens, who are found in small numbers in Northern Siam, chiefly in Me Hawng Sawn Province. The men of this tribe wear short red trousers and red coats; they usually have a rising sun tattooed on the small of their back. The women wear a red sin, barely reaching the knees; and a black scarf thrown over the right shoulder; they bind their legs below the knees with bands of black-lacquered cane. Headcloths are usually worn.

In other Karen tribes the unmarried women and girls wear a

long white smock reaching to the ankles. The married women wear a shorter, dark blue smock, reaching to below the hips, often ornamented with the white seeds of Jacob's tears, and a red skirt ornamented with blue, white and yellow patterns. The men wear a short smock, usually white with red stripes, and loose white trousers or sarong. In former days the men wore a smock reaching to below the knees and nothing else. The women are fond of silver ornaments, such as bangles and necklaces made out of coins.

The Karens in Siam have not generally adopted Buddhism and but few of them are Christians. Most of them remain animists. In their sacrifices to the spirits fowls are largely used. In Karen country, as a village is approached, it is very common to see curious bamboo-woven structures, daubed with fowl's blood and ornamented with feathers, placed by the side of the path. These are put up as an offering to appease evil spirits who might come that way and harm the village. The Karens burn their dead. After the cremation the young men and unmarried girls perform a curious funeral dance.

The Karens are very moral in their sexual relations and a man is content with one wife. They seldom intermarry with other tribes, as they will not leave their own villages for any length of time. Occasionally, however, a Lao marries a Karen girl, as many of them are good-looking, but in such a case he must go and live in the Karen village, as the girl will not leave it.

Most of the Karens live in the hills and cultivate forest clearings, but some of them have taken to the valleys, where they make permanent rice fields. In one point the cultivation of the Karens is distinguished from that of other hill tribes; they always plant among their rice a few purely ornamental flowers, the favourities being red and yellow cockscombs and the marigold.

The famous Marco Polo mentions the people of Karayan as living in Southern Yunnan, being a peaceable people tilling their fields and rearing cattle. No doubt the Karens are meant. Tradition has it that the Karens formerly formed a great kingdom on the banks of the Mekong, in what is now the territory of Northern Siam and the Shan States. If this be true their kingdom was

Photo by M. H. F. Swete

Karen village, N. Siam

Houses built entirely of bamboo.

probably broken up by the Tai coming down from Nan Chao.

Tin or Ka Tin

These are people living on the mountains in the northeast of the Nan Province, where they have some large villages.

Practically nothing is known of their language and they now dress like the Lao. It seems probable, however, that they are related to the Kamuk and Lamet. The latter is a race common on the hills to the east of the Mekong, but not known to come within the present boundaries of Siam.

The Tin live in large villages of well-built houses. Their chief industry is the cultivation of the tea tree, the leaves of which are fermented and used for chewing purposes only. This fermented substance, made up into round balls of a convenient size to go into the mouth, is called mieng.

Ka Tawng Luang or Pi Tawng Luang

But little is known about this very interesting tribe, indeed till a few years ago their very existence was doubted. In recent years, however, information about them has been accumulating.

The name Ka Tawng Luang means 'savages of the yellow leaf' and refers to their shelters of leafy branches stuck in the ground, which are abandoned when their leaves turn yellow.

The Ka Tawng Luang wander about in the mountainous region near the headwaters of the Menam Pasak and in the wilder parts of the Pre and Nan Provinces.

These people have very seldom been seen, but they sometimes carry on a system of barter with their Lao neighbours, this they do without appearing themselves. In a spot well known to the Laos they deposit jungle produce, such as rhinoceros horns, skins and honey, and then disappear. The Laos on finding the cache remove the jungle produce and place in return such things as salt, tobacco, cloth and iron. After the Laos have gone the Ka Tawng Luang come out and take away the goods left for them. Occasionally some of the men have been known to come down to a Lao village. On the other side of the Mekong they seem to be less timid and are said to visit Kamuk villages fairly frequently.

From their physical features it is evident that the Ka Tawng

Luang are not Negritos. Some of them tattoo their faces, the tattooing taking the form of a few horizontal or dotted lines on the forehead, along the edge of the hair, and on the lower jaw and chin. Both sexes of the Ka Tawng Luang usually go stark naked; the men occasionally wear a small loin cloth.

Their only weapon appears to be a long spear, with an iron head, which is sometimes poisoned. With this weapon they will even tackle the rhinoceros. They do no cultivation.

The student who requires further information on the ethnology of this country is recommended to read the very interesting chapter on the Races on Siam in Mr. Graham's book 'Siam'. Various articles on different tribes, often with vocabularies, have also been published in the Journal of the Siam Society.

CHAPTER VII

MINING IN SIAM

Siam has the reputation of possessing an abundant wealth of minerals, but it is not possible to say exactly when mining became an industry in Siam. It is, however, believed that casual mining operations have been carried on for many centuries past in the Siamese portion of the Malay Peninsula, and that the Chinese were the first people to undertake them.

The reason why the Chinese are thought to have been the first miners in Siam is explained by archaeologists and historians in the following way. Chinese traders in olden times used to travel by sea to India in their junks, and many, in order to shorten their sea journey, no doubt crossed the Malay Peninsula by land, probably landing somewhere near Nakon Sritammarat in southern Siam and re-joining their vessel again in the neighbourhood of Trang. At the same time, there may have been other routes, such as form Chumpon to Pak Chan. On their way across the Peninsula, they discovered by chance deposits of tin ore, which they naturally smelted and carried with them for their use. As times went on, they became more and more interested in, and attracted by, the mining opportunities afforded, and settled down to work the tin mines on a commercial basis and on a large scale.

At this early period mining lands and leases were easily acquired. Local Governors had, or arrogated to themselves, full powers to deal with such matters, and probably in many out of the way places boundary lines were demarcated according to the miners' own wishes. Overlapping consequently soon crept in and personal quarrels followed, in which the more powerful usually carried off the prize.

These conditions continued for a long time, and it was not until the fifth Reign that the Central Authorities stepped in and assumed charge of the mining industry of Siam. In January B. E. 2434 (1892) a Royal Department of Mines and Geology was established, European mining experts and engineers were engaged to organise a system, and all prospecting licences and concessions had to be forwarded to the Department for consideration. The Head Office, which was in Bangkok, was first of all attached to the Ministry of Lands and Agriculture, but was subsequently transferred to the Ministry of Finance in B. E. 2439 (1896-7).

In B. E. 2441 (1898-9), as Puket was the centre of the tin mining industry, a branch office was established there, which is still in existence.

In the year 2442 (1899-1900) the Department of Mines was re-transferred to the Ministry of Lands and Agriculture, where it has remained ever since.

Later on, the mining industry having grown extensively, further branch offices of the Department were established in the Provinces of Pangna, Renong, Takuapa, Trang, Songkhla (Singora), Nakon Sritammarat, Pattani, Yala, Betong, Surashtra, Langsuan, and also in Rajaburi.

In the year 2444 (1901-2), a Mining Law was introduced with a view to facilitating the work of the Administration. Both old and new leases were re-surveyed, and the legal holders of concessions became more secured in their rights.

As the tin-mining industry grew more and more prosperous, it was found necessary to revise the Law in order to cope more successfully with the situation that had arisen, and the present

Mining Law was promulgated in B. E. 2461 (1918-19).

Geology and Mineral Resources

Immense beds of limestone rocks resting on sandstone, very much foliated and broken by intrusions of granite and basalt, are the main geological characteristics of Siam. These intrusions, most violent in the southern parts, are the cause of the broken chains of bold, rugged and precipitous hills that flank the great mountain ranges and constitute the typical scenery of a great part of the country. In company with the limestone hills are beds of gneiss, mica, slate and schists, the results of the granite intrusions, while in certain localities, e. g. Chandaburi and Kanchanaburi, there are basaltic outcrops and in their neighbourhood millstone grit with gem-bearing gravels contiguous. The age of the sandstone and limestone beds has not been clearly determined. but they appear to be Old Red Sandstone, Devonian and Carboniferous formations of the Palaeozoic period.

There is not an active volcano in the country, but signs of volcanic action have been reported from Northern Siam by McCarthy.

There are abundant signs of a general upheaval of the land, probably still continuing. Marine deposits containing recent shells are found on the surface at a great distance from the sea, without alluvium upon them, while old beaches and river bars occur at places now far inland, which within historical times, were marine bays and estuaries.

Central Siam is nearly all alluvium, deposited upon limestone beds to the north and west and upon marine sands in the more central parts. Here and there highly tilted limestone beds stand up out of the alluvium as at Chainad, Phrabad and Krabin.

The geology of Eastern Siam is remarkable. The shallow basin, thinly covered with alluvium, with laterite freely exposed, that constitutes the whole district, being contained within low ranges of limestone and red sandstone. The limestone is rich in quartz and calcite, and outcrops of sandstone are frequent.

A few fossils have been found from time to time and identified, but the paleontology of the country has hitherto

received no very close study.

Among the various minerals occurring in Siam may be mentioned Cassiterite (Tin Ore), Wolfram and Scheelite (Tungsten Ores), Antimony, Copper, Coal, Gold, Iron, Silver, Lead, Molybdenum, Manganese, Zinc, Rubies, Sapphires, and Zircons.

Of these, however, only tin, wolfram and scheelite have been mined on a commercial basis to date. Tin-mining still continues to prosper and as an industry its future is assured, but the tungsten ores, wolfram and scheelite, are now mined only as by-products with tin-ore.

During the war period the abnormal demand created throughout the world for tungsten greatly enchanced the price, and both wolfram and scheelite were mined on a comparatively large scale, but with the cessation of hostilities, the rapid fall in price no longer made tungsten mining an economic undertaking and production is now negligible.

Tin

Tin-mining is particularly confined to the Southern Provinces of Siam on the East Coast, namely, Nakon Sritamarat and Pattani, and to the Puket Circle, which embraces the Island of Puket and the entire Western Sea Board of the Malay Peninsula belonging to Siam. In a lesser degree Rajburi Circle may also be included, but as a tin producing district, its future prospects do not appear encouraging.

The following table gives the total tin output (in piculs) for the four Peninsular Circles for the five years ending B. E. 2472 (1929-30).

CIRCLE	B. E. 2468 (1925-26)			B. E. 2469 (1926-27)			B. E. 2470 (1927-28)		
	Ores	Metal	Lead-Tin alloy	Ores	Metal	Lead-Tin alloy	Ores	Metal	Lead-Tin alloy
Puket	130,366	4,455	...	123,140	2,120	...	125,858	263	...
N. Sritamarat ...	34,640	...	...	32,719	...	...	41,093	12	...
Pattani	11,685	740	240	9,992	200	210	11,152	20	101
Rajburi	762	...	...	1,850	...	...	3,739	...	...
TOTAL ...	177,453	5,195	240	167,701	2,320	210	181,842	295	101

CIRCLE	B. E. 2471 (1928-29)			B. E. 2472 (1929-30)		
	Ores	Metal	Lead-Tin alloy	Ores	Metal	Lead-Tin alloy
Puket	139,151	..	..	176,264	..	..
N. Sritamarat ..	45,453	..	..	65,419	..	..
Pattani	10,437	..	1	11,579	..	..
Rajburi	3,797	..	..	3,611	..	..
TOTAL ..	198,838	..	1	256,873	..	..

It will be seen from the tabulated returns that Puket Circle is by far the most important district, contributing nearly 70% of the total tin production.

The island of Puket, formerly the outstanding tin producing centre in the Kingdom, has gradually become less productive and has passed the zenith of its prosperity, although doubtless there still remain certain new areas to be disclosed on this wonderful island.

The time has arrived, however, when prospectors have turned their attention to the mainland, and particularly to the Provinces of Renong and Takuapa.

Of the East Coast provinces Nakon Sritamarat is the largest tin producer, and during the last tin boom was the scene of great prospecting activities. Several new Dredging and Gravel Pumping Companies are now operating successfully and outputs are gradually improving.

Next in importance may be mentioned Pattani, which has not yet proved a very profitable mining field, but this condition may primarily be attributed to lack of enterprise on the part of prospectors. Last of all comes the Province of Rajburi further north. This Province, strictly speaking, should not be included, as Rajburi circle is first and foremost an agricultural district, mining being quite a secondary consideration.

Methods of Winning Tin

Practically all known methods of mining are employed in Siam, and comprise:—

(1) *Open Cast Mining*

(2) *Ground Sluicing*

Water conducted in open channels and released down the face of a slope.

(3) *Gravel Pumping*

(a) With hydraulic nozzles

(b) Without water pressure

(4) *Shafting*

(a) In lodes

(b) In Alluvium

(5) *Dredging*

(6) *Hydraulicing*

(a) With water under natural head

(b) With water under artificial head

(7) *Panning*

Washing tin in creeks and river beds.

A brief account describing the various methods of winning tin is given hereunder.

Open Cast Mining

Open Cast Mining is called in Siamese "Müang Hab" or "Müang Yai". When the mine is first opened up, the overburden is removed until the tin-bearing stratum, which is termed 'karang,' is reached; this overburden is at first stacked on the surface, but after the initial "paddock" has been opened, and as the working proceeds, it is usually stacked in the excavation from which the "karang" has already been removed.

The "karang" is generally washed during the actual working, so that the mine is entirely self-contained and all tailings are retained. The mineral thus obtained is carried to a shed, where a further washing is given. The tin is then dried and put into bags ready for transportation.

Ground Sluicing

Ground sluicing is a crude form of mining which finds favour

Boring.

Testing ground for Ore Deposit

with the poorer class of miner, as no large capital is required for equipment and plant.

Pay dirt, which is broken down by hand labour, is dumped into open channels into which water is conducted. Coolies, often women, here rake the dirt, the constant flow of water carries the lighter particles of sand along and the heavier tin ore is deposited. By means of gates which consist of removable plants placed across the open channels, the water supply can be regulated and periodically the payable material collected is removed in buckets and given a final dressing before being dried and bagged ready for the market.

Gravel Pumping

This method of mining is a great improvement on the ground sluicing system.

Material may be broken down either by means of water discharged under pressure through a nozzle, or by hand labour, but instead of coolie labour being employed to rake the material, it is conducted to a sump and the material then elevated by means of gravel pumps into a series of sluice boxes where the tin ore is saved.

By this method much quicker and more economic working is obtained.

Gravel pumping in recent years has become a very favourite method with the Chinese miners, and where the Chinese mines were in the past worked exclusively by hand labour, they are now being extensively equipped with modern mining machinery.

Shaft Mining

Shaft mining, "Müang Luang" or "Müang Plong", is a kind of underground mining.

In this case, instead of removing the overburden, only the "karang" bearing ground is removed ; and the amount of overburden carried away is only what it is necessary to excavate for sinking the shaft. When the shaft has been sunk, the "karang" is brought to the surface in buckets by means of pulleys, and washed ; and the tailings are generally allowed to flow back into the shaft when it is abandoned.

Bucket Dredging

Bucket dredging is mining with a series of iron bucket on an endless chain. An important event in the history of mining in Siam was the introduction of bucket dredging in the year 1907 by the Tongkah Harbour Tin Dredging No Liability.

The successful operation of this dredge, claimed to be the first dredge erected in this part of the world for tin winning purposes, soon proved the great possibilities of this method for the recovery of tin, and dredging has since established a firm claim on alluvial tin-mining and is generally the most favoured system as far as European companies are concerned.

With the advent of this dredge several more were introduced, and to-day there are altogether 38 dredges operating, or in course of erection in Siam.

The comparative table below gives the total output of ore (in piculs) from dredging and other sources during the last five years. As will be noted, an appreciable advance has been made in the output from dredging during the last year and, with a further 9 or 10 dredges operating next year, it is reasonable to forecast that future figures will show a steady overtaking of 'Outputs from other sources' by 'Outputs from dredging.'

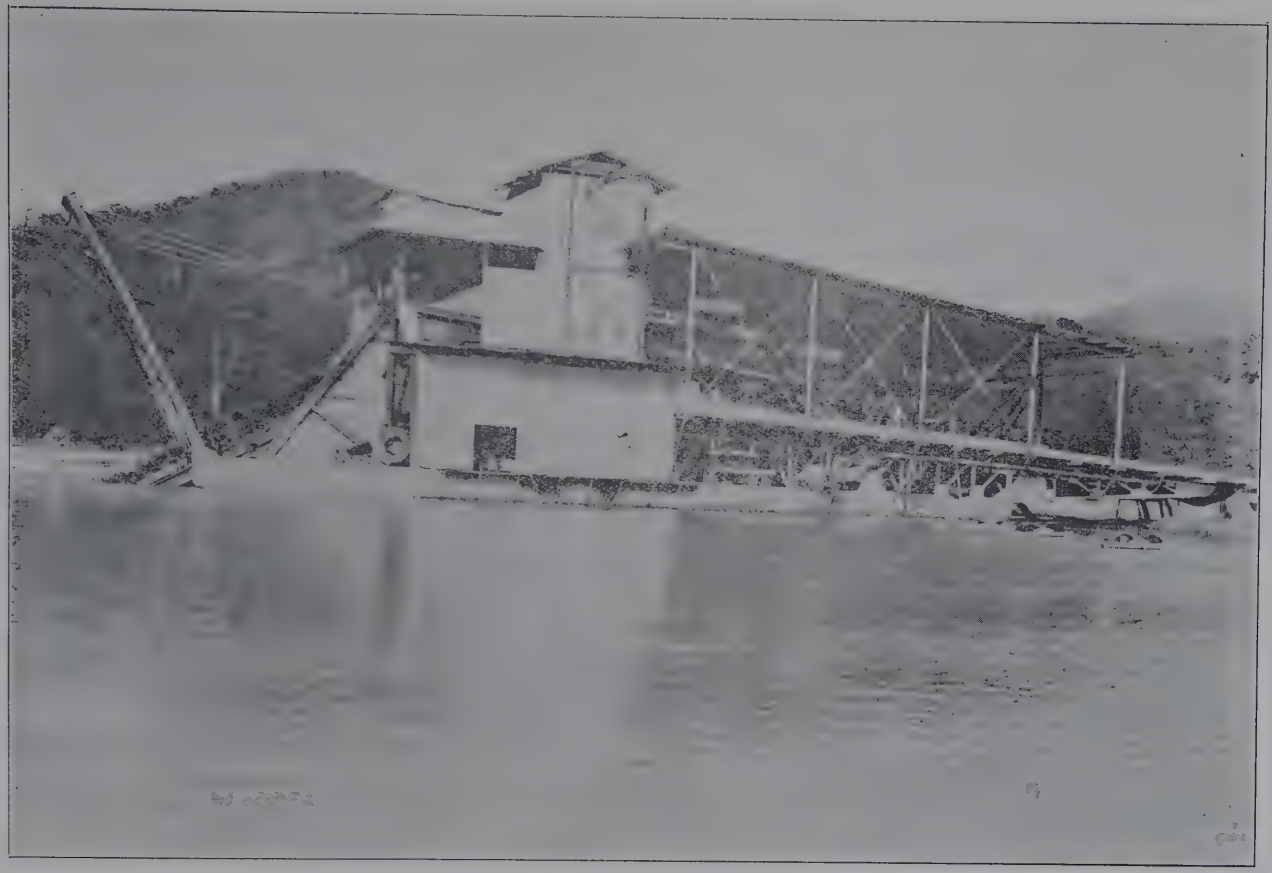
COMPARATIVE TABLE

YEAR	Dredging Tin Ore (Piculs)	Other sources Tin Ore (Piculs)
B. E. 2468 (1925-26)	68,549.52	108,903.94
B. E. 2469 (1926-27)	52,685.87	115,014.81
B. E. 2470 (1927-28)	56,614.83	125,227.29
B. E. 2471 (1928-29)	81,369.69	117,468.83
B. E. 2472 (1929-30)	132,746.21	124,126.62

One picul = 133.3 lbs.

Hydraulic Pressure

This method of mining tin is now much in vogue in the Malay Peninsula. It is a method of mining in which water under



Electrically driven Bucket Dredge.

pressure is used in breaking down the ground, directing it into sluices, washing the material, and permitting the tin to separate by its great specific gravity.

Providing there is a suitable dumping ground, this method of mining can produce tin very cheaply. At Nawng Pet, where the water comes from a considerable distance, the water pressure at the 'monitor' nozzle is about 250 lbs. per square inch.

Panning

The shape of the pan used is the same as the ordinary frying pan, but without the handle.

The pan being about half full of the ore, with an inch or so of water on the surface, is held firmly in one hand, while the other is used to shake the pan in a smooth but rapid manner, at the same time imparting a circular motion. By so doing the ore is gathered to one side of the pan, and the heavy grains of tin sink through the sand to the bottom and settle there. The water is then thrown out, the top layer of sand removed, fresh water is added, and the process of shaking begins again. This operation is repeated until nearly all the sand has been removed from the pan, and practically pure tin ore is left. This ore is then put into a tub or tin, and a fresh supply placed in the pan. To work the pan requires care and experience : and some become very expert in its use. The ordinary sheet-iron pan, from 16 to 18 inches in diameter, will hold from 15 to 25 pounds of 'dirt,' and by reason of its load will require the use of both hands during the washing operation. A good day's work for a placer miner, panning under medium conditions, is 100 pans of 'dirt' in 10 hours.

As no smelting works at present exist in Siam, all tin-ore won in the Kingdom is exported in the form of ore concentrates, and is shipped to Penang or Singapore.

In the past a certain amount of smelting was done by the Chinese on a small scale, but this practice has now ceased.

For the purpose of calculating the amount of Royalty payable, the tin-ore is reckoned to contain 72% metal, though in many cases the average metallic content of the concentrates is higher.

Gold

Gold is won on a small scale in many parts of the country, by Siamese and Chinese washing in the beds of rivers and streams. In the past, European Companies with large capital have attempted to work some of the deposits, notably at Tomoh, Bangtaphan, Wattana and Krabin. In every instance the result has been a failure, though how far this was due to the poverty of the deposits and how far to mismanagement, it is difficult to determine, but undoubtedly in many cases mismanagement played an important part. On a smaller scale capital has been spent in opening mines at Lomsak in Petchaboon and at Pu Kiriu in Lopburi, with equally unsatisfactory results. In all the above-mentioned places small amounts of gold are still won by the local inhabitants, but these operations can hardly be said to constitute a regular industry, as most of those engaged in gold washing regard it as an occupation for their spare time only. At Tomoh, where the alluvial deposits are nearly worked out, a certain amount of lode mining is carried on by Chinese.

Copper

An unsuccessful attempt was made some years ago by Danish capitalists to work a copper mine at Chantuk on the way to Korat, and samples of copper ores are occasionally brought in from different parts of the country for identification. Most of these samples are sulphides, but one specimen of native copper has been identified.

Lead

Lead is found associated with tin in some parts of Jala, in Pattani Circle, the lead occurring as carbonate and sulphide and the tin as oxide. Owing to their having close specific gravity these ores cannot be separated by the ordinary methods of water-concentration, and this is a source of much annoyance both to the miner and smelter.

Lead in the form of galena, carrying a small percentage of silver, occurs in Kanburi, and probably in several other parts of the country, but has not up to the present been worked on a commercial scale. If the economic conditions are very favourable,

Dressing Tin Ore ready for market.

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it may still be hoped that lead mining will one day prove a profitable venture in Siam.

Molybdenum

Leases have recently been issued for the working of molybdenum in the Province of Chantabun, but, as in the case of wolfram, the special demand for this mineral came to an end after the close of the war, with the result that stocks were soon accumulated capable of supplying the world's normal demand for the following two years, and the price dropped back to a figure which would be unlikely in most cases to cover the cost of production.

Iron

Iron is widely distributed throughout Siam in the form of haematite, limonite and ilmenite, with some magnetite. No attempt has so far been made to mine iron on a commercial scale, but the metal is produced for local consumption in various districts.

Coal

For many years past coal has been known to exist in the Krabi Province of Puket Circle, and a certain amount of capital has been expended in examining deposits there. Tests made of the coal so far obtained from this source appear, however, to have been somewhat discouraging, and further exploitation has been abandoned. The occurrence of coal in the Province of Trang and Surat resulted in the formation of a Company in Bangkok to work the deposits. The coal produced was a poor grade lignite and did not prove an economic commodity and after an unsuccessful endeavour to establish a new industry in Siam, the Company went into liquidation.

Gems

With the cession of the Pailin district in Battambong to the French in 1907, the gem mining industry in Siam ceased to have any importance: but a certain amount is still carried on in the districts of Krat and Chantabun adjoining Pailin: and the Customs returns show the export of rubies and sapphires in the rough, which probably have their origin in these districts. The occurrence of a sapphire bearing formation in the Province of Kanburi

was reported in 1921. A Royal Decree was promulgated about the same time, bringing gem mining within the purview of the Siam Mining Act 1919. Special regulations were drawn up, and several applications were received for the right to mine gems in the new locality.

During the year B. E. 2470 (1928) two permits to dig for gems were in force, and several thousand carats were unearthed. Owing to the success achieved by these owners the gem mining industry rapidly revived and three further gem mining leases were granted in 1929.

Great activity now prevails in Kanburi and much excitement has been caused in the district by the discovery of several valuable stones of premier quality and size.

Tin Royalty

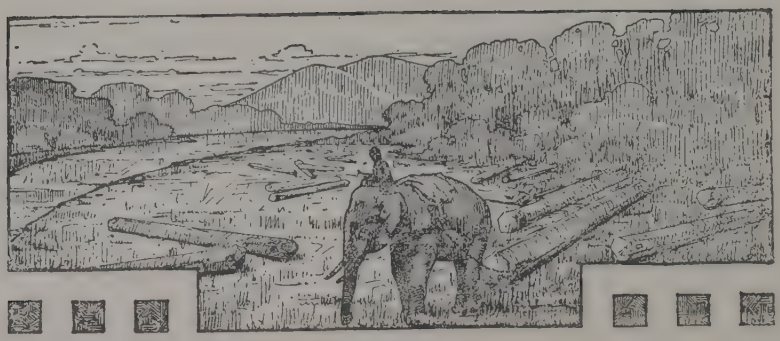
The greater part of the revenue derived from mining is obtained from the royalty collected on tin and tin-ore, the balance consisting of payments made on account of rents, fees for prospecting and exclusive prospecting licences, &c. The tin royalty is based on a sliding scale and calculated on the current price of the metal on the Singapore market. The following table shows the revenue derived from tin mining during the last five years, and the average price of tin in Straits currency on the Singapore market for the years in question.

YEAR	Average price of tin in $ per picul.	Revenue Baht (Ticals).
B. E. 2467 (1924-25)	123.58	3,165,935.38
B. E. 2468 (1925-26)	134.36	3,789,468.18
B. E. 2469 (1926-27)	147.42	4,325,504.44
B. E. 2470 (1927-28)	136.88	4,016,353.21
B. E. 2471 (1928-29)	111.80	2,971,425.45

Transporting tin-ore from mines.

In the year B. E. 2470 (1927-28), the area of land alienated for prospecting and mining was 490,095-0-00 rais and 116,396-0-00 rais respectively ($2\frac{1}{2}$ rais = 1 acre).

There are some 60 tin-mining companies registered in Siam, but in addition to these there are many small concerns, run and owned by Chinese and Siamese. Collectively these small-holders represent the larger portion of the mining community of the Kingdom, and 80% of the return of ore from other sources given in the comparative table is derived from this section of the unlisted mining community.



CHAPTER VIII

FORESTRY

Siam is essentially a forest country; with the exception of the great central rice plain, lying directly north of Bangkok, the rest of the country is largely covered by tree or woody growth of many kinds and types. The total area of Siam has been estimated at 200,000 square miles and it is reasonable to suppose that 50–60% of this is covered by some kind of woody vegetation.

From its geographical position, bounded on the west by Burma, on the east by Indo-China, and occupying most of the Malay Peninsula as far south aslatitude N 5°37′, Siam possesses a very tropical climate and extraordinary range and variety of vegetation, making up many different types of forests.

THE TEAK FORESTS OF SIAM

The Siamese Teak Forests have been in the past and still are the most valuable and important forest state property in the country. They will be dealt with first.

I. Situation and Areas, Topography, Geology and Soils, Climate

(a) *Situation and Areas*

The Siamese teak zone is situated mainly between latitude 17°N and the northern boundary of the country in latitudes 19° 40′ to 20° 30′. It thus extends over the whole of the northern portion

of Siam, but within this zone the teak tree only grows in certain localities where the general conditions are suitable. The total area of this zone has been estimated at 107,000 square kilometers or 41,000 square miles, and it is probable that the teak producing areas do not exceed 30,000 square kilometers or 11,000 square miles.

(b) *General Topography*

No general topographical survey has yet been made in Northern Siam. The region may be described as hilly, and even mountainous in places. The highest mountain in Siam, Doi Intanon or Angka, 2550 metres or 8,450 feet in height, lies within this region, and Doi Sutep mountain just west of Chiengmai, the capital of Northern Siam, attains a height of 1650 metres or 5,500 feet.

The hill and mountain ranges run north and south, more or less parallel to one another, and the main rivers and streams follow the main valleys between the ranges.

The whole zone is traversed by a vast number of waterways of varying size and nature. It contains eight main drainage basins; two small basins of the Me Pai and Me Yuam Rivers, draining westwards into the Salween River, which flows through Burmese territory to Moulmein; two other small rivers in the N. E. corner of this zone flow eastwards into the great Me Kong River; the four remaining large rivers, the Me Ping, the Me Wang, the Me Yom and the Menam Nan have their basins completely within Siamese territory and flow southwards, all meeting at various points to form, finally, the main Menam Chao Phya which flows past Bangkok. Owing to the geological formation, in places these river basins are cut up into sections, and these sections are connected up by narrow canyons or gorges forming rapids or "narrows" in the courses of the river.

(c) *Geology and Soils*

No geological survey nor systematic geological work has been done in Northern Siam.

The geological formations of this region are very varied and complicated. The whole country forms a series of synclinal and

anticlinal folds runing in north and south direction, composed of many different structures.

In these, granite is a conspicuous feature. A long continuous belt of granite runs down the entire length at about the centre of the zone, with intrusions of basalt and other igneous rocks. Scattered intermittent outcrops of hard and highly crystallized limestone occur throughout this zone, forming narrow ranges of hills with sheer cliffs.

Shales and slate formations of very varied composition often occur between the limestone outcrops.

Sandstone formations form conspicuous features at many points, they are of very varying compositions.

Both in Northern Siam and also in many other parts of the country, there are large stretches of laterite, producing red or pinkish soils with characteristic vegetation. The main valleys usually 12-15 miles (20-30 kilometres) wide are flat, containing both bedded sedimentary deposits and alluvium. Between the valleys and the main ranges are usually found broken and irregular foothills, whose rocks are much weathered. On such areas the teak tree often attains its finest proportions.

The teak tree will grow on soils derived from most of the geological formations in Northern Siam, except laterite. It is commonly found growing on soils derived from granite, sandstone and limestone formations, possibly it flourishes best on the last-named.

It prefers deep well-drained loam; it may be found growing even in the valleys on alluvium, but it cannot stand prolonged water-logging. Taking it all round it is a very accommodating tree.

In Northern Siam most of the teak-bearing areas are found between 600 feet (200 metres) and 2,500 feet (750 metres) elevation. In other parts of the world it grows at considerably higher altitudes.

(d) *Climate*

The climate of the teak zone in Northern Siam is extremely tropical and subject to great ranges of temperature.

The cool season is from the middle of November to the middle of March, during which the mean temperature keeps below 76° F. and the nights are often very cold. The hot season is from then up to the break of the rains in May and June and the temperature may go as high as 110° F. The rest of the year constitutes the rainy season, when rain falls constantly, but intermittently. The average annual rainfall is about 48 inches.

II. General Description of the Teak Forests

The forest vegetation of Northern Siam is extremely varied and complicated. It may be broadly divided into three classes. But it often happens that these three classes are not sharply distinguished, but merge into one another, thereby forming all sorts of intermediate types.

(a) *Lateritic Forests*

These are forests growing on soils in which the underlying rock is lateritic. The decomposition of this rock produces red or reddish soils of varying depth and nature. The usual soil produced is red clay or reddish loam and sandy loams. Sometimes the soil is so shallow that the trees are growing on practically bare rock and are consequently very stunted.

The soils produce a varied but characteristic vegetation, but speaking generally the teak avoids such localities and cannot grow in them, although it may sometimes be found just merging into and overlapping such areas.

(b) *Evergreen Forests*

These are moist types of forests, containing stands of heavy evergreen trees; growth is thick and impenetrable with dense undergrowth of bamboos, canes, palms of various kinds, and masses of creepers and climbers entering the trees; on the trees themselves are found growing a wonderful variety of orchids, tree-ferns and other kinds of epiphytic plants.

Such forests are found on deep rich soils in very damp localities. They are characterized by a number of well-known species, especially various members of the *Dipterocarpus* genus, *Hopea*, especially *Hopea odorata*, and many other species.

The teak bearing areas in places merge into the evergreen

forests, but the teak tree is gradually extinguished by the overpowering evergreen vegetation and by the excessive dampness of such localities.

(c) *Teak-bearing Forests*

The teak tree is a fine large deciduous tree, with a thin grey bark and large oval-shaped leaves, one to two feet long.

Under favourable conditions it grows with a tall straight cylindrical bole, often buttressed at the base, and a fine well-developed, rounded crown.

Its distribution in the world may be briefly summarized as follows:—throughout the Peninsula of India, wherever conditions are favourable, throughout most of Burma, in parts of the Shan States, throughout Northern Siam, wherever local conditions are suitable, in parts of Java, on the extreme west of French Indo-China; it has been successfully planted in various parts of the world.

It is essentially a tropical tree and cannot stand great cold. It flourishes best in a warm, fairly moist, tropical climate. It grows best with a rainfall of 40-70 inches, although it is known to grow in various places between such great extremes as 30-150 inches of rain annually.

During its earlier years the teak trees grow fast, but this rapid rate of growth soon slows down, and during middle life and old age the growth is very slow, so that on the whole, it usually takes from 140-160 years for a teak tree to attain 7 feet in girth.

It is probable that in Northern Siam it attains as large and as fine proportions as anywhere in the world. The largest teak known to be standing in Siam has a girth of 29 feet 5 inches at breast height; total height 151 feet; height of bole 77 feet.

The teak tree is a very light-demanding tree and as a rule non-gregarious. It does not form large stretches of pure forest.

The general type of teak-bearing forest in Northern Siam is known as the mixed deciduous type. In these forests there are a vast number of deciduous trees of different species all mixed up together, with the teak growing, here and there, in small groups, patches and "pockets"; often the teak only appears as scattered

single trees.

For practical forestry purposes it is usual to distinguish teak forests as "dry" and "moist" types. In the "moist" types evergreen trees are prominent and such types gradually merge into evergreen forest where the teak completely disappears. Teak in the "moist" grows rather faster than in the "dry" types.

The oecology of this teak region is so complex and there are so many intermediate types that, with the present knowledge, it is difficult to lay down any hard and fast rules on the subject.

The following are some of the commoner trees associated with the teak in the mixed deciduous forests :—

Pterocarpus indicus, Pterocarpus macrocarpus, Xylia dolabriformis, Xylia Kerrii, Schleichera trijuga, Lagerstroemia tomentosa, Lagerstroemia calyculata, Lagerstroemia Balansae, Afzelia xylocarpa, Adina cordifolia, Stephegyne parvifolia, Terminalia mucronata, Terminalia tomentosa, Terminalia belerica, Gmelina arborea, Mangifera caloneura, Anogeissus acuminata, Irvingia malayana, Elaeocarpus lacunosus, Vitex limonifolia, Vitex peduncularis, Chukrasia velutina, Odina Wodier, Garuga pinnata, Tetrameles nudiflora, Spondias mangifera, Sterculia spp. and many others besides.

The undergrowth in the teak forests is of varied and characteristic composition. It is chiefly composed of bamboos, and many kinds of undershrubs. In places small palms and cycads appear. The following are the commoner kinds of bamboos found in the teak forests :—*Thyrsostachys siamensis*,—the umbrella handle bamboo or monastery bamboo as it is called in Burma, —*Oxytenanthera albociliata, Bambusa Tulda* (the common bamboo of Bengal), *Dendrocalamus membranaceus* and *Dendrocalamus strictus*, the male or solid bamboo and *Bambusa polymorpha*. *Cephalostachyum pergracile* is much found in the moist teak forests.

In the southern portions of the teak zone, large thickets of *Bambusa arundinacea*, the thorny bamboo, occur on flat and alluvial areas near the banks of streams.

III. A General Account of the work of the Forest Department in Northern Siam, with Special Reference to Teak Trade and to the Development of the Teak Leases

Originally the control of the Siamese teak forests was in the hands of the Lao Chiefs and they issued kinds of leases or permits to various traders chiefly Burmans and Shans and Chinese. These worked the forests in irregular fashion causing great confusion thereby.

But in the late eighties and early nineties of the last century, a number of European firms entered the teak trade and thereby caused great changes to come to pass, by gaining predominant control in the teak industry.

As there was considerable danger of the teak forests being rapidly over-worked and exhausted, the Siamese Government decided to start a Forest Department and they engaged the services of an experienced British Forest Officer from Burma, Mr. H. Slade, for that purpose.

Mr. Slade arrived in 1896, and the result of his activities may be briefly summarized as follows:—

(a) A small regular staff was recruited, chiefly British with some Siamese, to carry out the work of the new Department and to replace the agents and servants of the Lao Chiefs, who had hitherto done the work. Also young Siamese were selected and sent abroad to study forestry.

(b) The area comprising the teak forests was divided into divisions for purposes of control. The forests were explored and rough explanatory maps of them were made. General information and data on the forests were also collected.

(c) In order to regulate and control the output of the teak forests, a system of regular leases was started and nobody was allowed to work any forest without holding a regular lease granted by the Siamese Government.

The main provisions of these leases were that each forest was divided into two halves, each half to be worked over in 6 years. Thus the total period in which the entire forest was to be worked over, known as the Felling Cycle, was 12 years, and no teak tree

below 6 feet 4½ inches girth at breast height and in some leases 7 feet girth could be felled.

In some cases no further girdling of teak trees was permitted, owing to accumulated girdled stocks, in other cases 2 out of 5 trees were allowed to be girdled.

The royalty or taxation payable on teak logs extracted was raised from Rs. 4½ to 10 on teak logs of 38 cubic feet contents and above and to Rs. 6 for all smaller logs.

A number of other regulations and penalties governed the working of these leases.

(d) The Siamese Government assumed administrative and technical control over the teak forests and the Lao Chiefs became sharers in the profits only.

(e) A certain amount of forest legislation in the form of Royal Decrees was brought into force to promote the regular working and protection of the teak and to eliminate malpractices.

(f) The felling and removal of young undersized teak trees, which had previously been done in wholesale fashion, to the great detriment of the forests, was stopped. Timber stealing was reduced to practically nothing.

(g) A Timber Revenue station was started at Paknampo, the southernmost junction of the Siamese rivers, about 155 miles north of Bangkok. All teak timber extracted by European lessees was floated down to this station, measured there and royalty duty collected there. Rates of duty were Ticals 3.26 for full sized and Ticals 0.80 for small logs

Whereas all logs extracted by local lessees were measured and paid royalty in the forests and were re-measured and paid duty on arrival at Paknampo, but logs of the European lessees paid both royalty and duty on arrival at the Duty Station.

For logs passing down the Salween River into Burma a Duty Station was started at Kado, a short distance north of Moulmein.

This kind of teak lease lasted down to 1909. In this year, as most of the teak leases were then expiring, it was found necessary to re-organize and improve the entire system of teak leases and to put them on a different basis.

The following summarizes the main points connected with this re-organization.

(a) The European firms had obtained their leases originally from Lao Chiefs, by various means, and this had resulted in the formation of a large number of small scattered leases, uneconomic to the lessees concerned and difficult of control for the Government.

By exchange the areas of the leases were readjusted and the numbers of leases reduced from 105 to 40.

(b) The Felling Cycle of 12 years had proved too short, it was lengthened to 30 years. Each teak lease was divided into two halves of approximately equal productiveness. Each half to be exploited over 15 years, all teak trees over 6 feet 4½ inches to be girdled and felled, except certain trees reserved for sylvicultural purposes.

(c) The royalties payable on teak timber were raised 20%. The selection and girdling of teak trees was done by lessees, except in the local leases where it was done by forest officers.

In 1913-1914 a Royal Decree was brought into force for the protection of species of trees other than teak, growing in Northern Siam. By this Decree all kinds of trees other than teak were divided into two classes, Unreserved and Reserved.

Anyone can fell and use Unreserved kinds of trees without restriction, but anyone wishing to fell and use any species of Reserved trees must take out a permit to do so and must pay the fees or royalty fixed by the Government. Free permits of Reserved trees are issued to local people for home consumption and also for religious and charitable purposes. In order that the extra work, involved in the carrying out of this Decree, might be coped with, the staff of the Forest Department was increased.

In 1925, the existing teak leases having come to an end and half the leased areas having been worked over, the new leases started, and have now been in force for the last five years.

These leases are also for a period of 15 years, and they present a number of improved features over the previous leases, of which the following is a summary:—

(a) The selection and girdling of the teak trees is being

done by the Forest Department instead of by the lessees.

(b) The exploitable girth has been raised to 6 feet 8½ inches in all European leases, and 6% of the best trees are being reserved.

(c) The metric system of measurement has been introduced for measuring the teak logs instead of the former local system, known as the pikat system. Standard rates of royalty for average forests have been fixed at Ticals 12.50 per ton of 50 cubic feet (8.83 cubic metres) and smaller rates for smaller logs.

(d) Waste has been reduced by binding the lessees to fell trees near ground level, and to use saws in logging.

There are 33 teak leases now in force.

The following is the list of lessee-firms working under these leases; besides these there are a number of local lessees, holding smaller leases and a small area of forests worked departmentally by the Forest Department.

British Firms. The Bombay Burmah Trading Corp., Ltd.
The Borneo Company, Ltd.
The Anglo-Siam Corporation, Ltd.
Louis T. Leonowens, Ltd.

Danish Firm. The East Asiatic Company, Ltd.

French Firm. Est Asiatique Français.

Chinese Firm. Lam Sam.

Approximately 85% of the teak forests are worked by European firms, 14% by local lessees and 1% by the Forest Department.

The Forest Department is under the control of the Minister of Agriculture.

There are six Forest Divisions comprising the teak zone, and the total staff is divided under the following heads:—

Controlling Staff.
Subordinate Staff.
Clerical Staff.
Menials.

IV. System of Management, Statistics

(a) *System of Management*

The general system of management is based on the Brandis

Selection System, which was started in Burma many years ago and is still largely practised in that country. The practical operation of this system is, very briefly, as follows:—

Exploitable girth is fixed, below which no tree can be felled. A felling cycle is fixed, and this corresponds to the number of years it takes for the smallest tree in the girth class below that of the exploitable girth, known as Class II, to grow and become of exploitable size. The trees of exploitable size are known as Class I trees. This Felling Cycle has been fixed in Northern Siam at 30 years, which is the figure generally adopted in Burma.

The whole forest under operation is therefore felled over a period of 30 years, only trees above the exploitable girth being removed.

At the end of this period it is hoped that all the Class II trees will have increased in girth and become Class I trees, again ready for felling.

(b) *Statistics*

The following is a brief summary of some of the more important statistics, bearing on the exploitation of the Siamese teak forests.

Extraction of teak logs takes place by water down three rivers on the western watershed and down the Salween River to Moulmein in Burma, in the centre down the Menam Chao Phya to Bangkok and on the east down the Mekong through Indo-China to Saigon.

The total number of teak logs thus extracted down these three rivers, during the past 30 years is 3,169,296.

The average number of teak logs brought down the main river to Paknampo and Bangkok annually is 80,545.

Similar figures down the Salween River on the west are 18,778, and down the Mekong River on the east 8,118 logs.

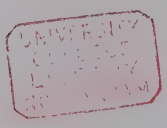
The average annual number of teak logs for the whole of Siam during the past 15 years is 107,433.

The average cubic contents of teak logs arriving in Bangkok is 74.70 cubic feet or 2.11 cubic metres.

The total amount of revenue levied by the Siamese Govern-

Felling.

Hauling.



ment on the teak timber during the past 30 years is Ticals 44,822,272.

V. System of Exploitation and Transport

Every teak tree to be felled, is first of all selected, measured, numbered and recorded in a Girdling Statement by the Forest Officer in charge of this work.

The tree is then girdled. This consists in cutting a ring round the trunk of the tree, about the width and depth of a man's hand. The cut goes through the bark and bast into the heart wood. The effect of this girdling is to kill the tree slowly. Every teak tree to be felled must be girdled at least 2 years in advance, thus by the time the tree is felled it is sufficiently dry to float.

Teak timber has the property of floating when it is dry, but not when it is green. As the transport is by water, it is absolutely necessary to dry the wood first.

The tree is then felled with saws as near the ground as possible—all branches are trimmed off and the bole is then cut up into suitable lengths, which are hammered with identification marks.

Felling operations take place during the rainy season, the chief reason being that the bole being dry is less likely to be damaged falling on soft ground.

One or more elephants are then harnessed to the logs and they drag these to the nearest floating stream and place them lengthways with the stream-bed. Dragging also takes place in the rainy season because the logs slide along more easily in the mud. When the streams fill and flood with the rain water, the logs are carried down towards the main rivers.

Whenever the logs pile up and jam, thus forming stacks, parties of men and elephants go down the streams; elephants are trained to push these logs out into the stream-flow and thus to set the mass of logs floating downstream again. This operation is known as "ounging".

This work goes on down all side streams until the logs reach the main rivers; there the accumulation of logs is often enormous

and the work of breaking up the jam and keeping the logs moving downstream is often very arduous and sometimes even dangerous.

Owing to the number of rapids it is impossible to raft on the northern portions of the main rivers, and the logs have to travel down singly for about 150 miles. On each of the main rivers there is a rafting point, south of all rapids, where agents employed by all the lessees catch the teak logs, sort them out and make them up into long rafts, containing about 200 logs each, and float these down either to Moulmein, Bangkok or, in the case of the north-eastern forests, right down the Mekong River to Saigon.

At the end of the rafting season, when the rivers go dry steps are taken before the end of the year to break up all stacks left, this is affected by parties of men and elephants. The elephants, guided by their drivers pull out the "key" logs with wonderful skill and thus all the logs are laid out separately in the beds of the rivers. Fire protection has also to be undertaken by burning fire-lines and employing fire-guards. The danger from fire is great, because the greater part of the teak forests are burnt from end to end every year. Timber stealing is also a danger.

Rafts stranded in the rivers must wait for the river to rise on the following year and similar protective measures have to be undertaken. It is estimated that on the average, it takes about 5 years for a teak log to arrive in Bangkok, from the spot where it was originally felled.

Beside these ordinary floating methods, a number of other means are employed in the transport of teak, which may be briefly outlined herewith :—

(i) Of recent years, during the hot weather months when elephants cannot work, carting of teak logs to the larger streams has been largely adopted.

The local Lao population have become very adept in carting all sizes of logs; for the heaviest logs they sometimes use 8 to 10 pairs of buffaloes or 10 to 15 pairs of bullocks.

(ii) A good deal of miscellaneous river training and clearing of streams is done by lessees, chiefly by blasting; in some cases

Hauling logs.

Carting logs.

lessees have erected works of some importance. Thus The Bombay Burmah Trading Corporation, Ltd. erected a large earthen dam with lock gates at the head waters of the Me Taw creek in the Raheng Division, to create artificial rises in the stream, and thus clear the logs lying in its bed. The Est Asiatique Français have canalized streams running through swamps and erected stone and earthern dams to raise the level of the waters and facilitate the passage of the logs. Messrs. Louis T. Leonowens, Ltd., have erected log dams in some of the streams of their leased areas, to attain similar results.

(iii) Mechanical transport, nowadays, is becoming every year a more important factor in the transport of teak logs. The Anglo-Siam Corporation, Ltd., have completed the finest logging line in Northern Siam, in their Prayow-Me Chune leased areas, in the Lampang Division. The line is constructed through difficult country, its total length is 49¼ miles, it is metre gauge and 7 steam locomotives are employed in hauling the logs, which are rolled down into the Me Yom at the end of the line.

The East Asiatic Company, Ltd., have built a tramway in their leased areas in the Prae Division about 10 miles long and 30 inches gauge, elephants being employed to haul the log-truck. The Borneo Company, Ltd., have constructed 3.12 miles of tramway over a difficult watershed at Muang Fang in the Chiengmai Division. The gauge is .75 metres and elephants are used for hauling the trucks. The logs pass from the end of the tramway down a big chute or slide.

The Est Asiatique Français have introduced the Decauville tramway system into their Mekok leased areas in Northern Siam, and The Bombay Burmah Trading Corporation, Ltd. are building a logging line in their leased areas in the Lampang Division.

Messrs. Louis T. Leonowens, Ltd. are employing tractors for hauling teak logs in their teak concessions.

(iv) Both wet and dry slides have been used in the past and are being used now. The most notable now in use is that erected by The Borneo Company, Ltd. in their Muang Fang leased

areas, which has already been mentioned in connection with their tramway. This chute is a dry timber slide, just over half a mile long, built of jungle-wood lengths, each length 2 to 2½ feet in girth. The slide has several curves down its course.

From the above it may be understood that both modern as well as ancient methods of log transport are in use in Northern Siam.

VI. The Chief Products of the Siamese Teak Forests

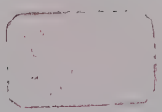
The main product is of course teak timber, which is world-famous as being the finest all round timber in existence. It derives its great reputation from its striking combination of all the good qualities that a timber should possess and none of the bad qualities. It can be used for all sorts of purposes and it stands out pre-eminently as the finest ship-building timber in the world.

The timber contains little sapwood and much heart wood. The heartwood is moderately hard, scented, and contains an oil which is its chief preservative. It is dark golden yellow in colour, turning brown and dark-brown with age. Very old teak timber is sometimes almost black. The durability of teak timber is celebrated. A number of beams and other pieces have been taken out of old buildings in various eastern countries, in perfectly sound condition, which had been in situ for 500 to 600 years.

The structure of teak timber is very regular and the annual rings are clearly marked by lines of pores. It is one of the very few tropical trees producing regular and reliable annual rings. It sometimes produces beautiful figuring, which is commonly referred to as "flowered teak-wood".

Besides the teak, there are growing in these forests very many other kinds of trees, some of them producing excellent timber. Nearly all these timbers are hard and heavy and will not float in water. As the land transport by train is long and expensive, it is generally impossible to export them at a profit, and on account of the rapids in the rivers, it is impossible to bring them down from this northern territory in rafts buoyed up by bamboos.

Teak Nursery.



There is a certain amount of local trade in some of the better class timber and the villagers also use many other kinds for home consumption.

Of these other-wood timbers exported from the teak forest areas the two most prominent are *Pterocarpus indicus* and *Pterocarpus macrocarpus* (mai pradoo), producing dark red close grained heavy wood. This timber is much worked out by Chinese traders on permits and exported by train to Bangkok, whence it is despatched to China for furniture making. These two timbers are also much used locally. Another timber whose export is increasing annually is mai tabek, produced from *Lagerstroemia calyculata* and *Lagerstroemia Balansae*. The timber of these two trees is much alike and has the property of floating in water after being dried for one year. The timber is yellowish and of medium quality. A good deal of it is rafted down to Bangkok from the North every year. *Lagerstroemia tomentosa* (mai salao) closely allied to the above is also much exported by water.

One of the best known local woods is produced by *Xylia dolabriformis* (mai deng) whose timber is extremely hard and heavy and of dark red-brown colour. It has considerable local use for house building, especially for house-posts.

Adina cordifolia (mai kwow), a common tree in the teak forests, produces a moderately hard even-grained yellow wood, much used for turnery in some parts of the East and also used for many domestic purposes in Northern Siam.

Gmelina arborea (mai saw) produces a remarkable timber which is both light, durable and strong, much used in Northern Siam. The tree is common but very scattered and it is probably for this reason that an export trade in this excellent wood has not been developed.

Two species of *Dalbergia* (mai ket dam and mai ket deng) produce timber akin to blackwood or rosewood, but of inferior colour and quality. At times considerable export trade in these has developed, but it is very fluctuating.

Vast quantities of bamboos of many different species grow in the teak forests, which are put to all sorts of local uses and play

a great part in the economic life of the people, but owing to the great distances involved there is no regular export of these.

Lac is becoming every year an increasingly valuable product from Northern Siam. It is the resinous excretion of certain insects, of which the most important is *Tachardia lacca*, deposited as an encrustation on the branches and twigs of trees. Wild lac occurs naturally on forest trees of many species, growing in the teak forests. It is gathered by hand and railed down to Bangkok, whence it is exported all over the world. Lac can also be cultivated by tying pieces of what is called brood lac on to the branches of trees. This brood lac is the lac containing the insects before they have swarmed on to the tree. The cultivation of lac is being rapidly extended in many districts of Northern Siam and lac-bearing trees are being planted.

Lac is very much in demand for use in various industries especially in the manufactures of gramophone records. In 1928-1929 57,433 piculs of lac, valued at Tcs. 3,925,717, was exported from Siam, but the price has always been a fluctuating one.

VII. Conversion and Export of Siamese Teak Timber

(*a*) *Preliminary*

On arrival at Paknampo, the Forest Duty Station, the teak logs in the raft are measured, their cubic contents calculated and Government dues on them collected. The logs are then examined by representatives of the lessees who pick out all unsuitable logs and sell them locally. It is estimated that 33% of the total number of logs are sold thus.

The rafts then proceed down river to various storage grounds, where they are stored in the water till required at the saw mills.

At the storage grounds, the logs are again examined and classified, and floated down to the sawmills.

(b) *Milling and Conversion of Siamese teak timber*

Siamese teak timber is very irregular, both in shape and quality, so that its conversion and milling has to proceed by very different methods to those employed in sawing up regularly shaped timber. Every log has to be carefully examined and decisions

taken on its individual merits.

The chief object of the European firms milling teak in Bangkok, is to produce as many and large squares or baulks from the timber as possible; slabs from logs are sawn up into scantlings and even smaller sizes. Large defective logs are sawn entirely into planks and scantlings.

All teak timber unsuitable for export finds a ready market in Bangkok, and is purchased by the small local millers or hand sawyers, for conversion into smaller pieces.

All fuel residue from the teak sawmills is easily sold locally as fuel, and the sawdust and shavings are used as fuel for the mill furnaces.

Thus there is practically no wastage at all, whatever the actual amount of export timber taken from the logs may be.

There are five large European teak sawmills in Bangkok, two or three large Chinese mills and a whole lot of smaller sawmills and hand saw-pits operated by Chinese and other nationalities.

The large mills use large circular saws, frame saws with two paralled vertical saws and band saws for breaking down the logs; cross cutting saws are used for crossing-cutting the logs into shorter lengths and small circular saws for sawing scantlings and smaller sizes. Band saws are a comparatively modern innovation in Bangkok and expert opinion is not yet united as to their suitability in sawing up a timber as hard as teak, which is only classed as moderately hard wood.

(c) *Defects of Siamese Teak Timber*

Round teak logs present a great contrast to ordinary regularly grown timber, by reason of their irregular shape and condition and by reason of many defects apparent in them.

This is chiefly due to their irregular habit of growth, and to the many vicissitudes through which they have to pass during their long life of about 150 years in tropical forests.

It is well to remember that they grow in a tropical climate with great extremes of temperature, that they are subject every year to forest fires and that they often stand for some years in a dead and dry condition after girdling.

The defects may be briefly divided into three classes. Firstly defects of growth, producing crooked logs generally known as crooks, which are sometimes valuable for special purposes, branchy growth producing knots which often become rotten, opening up rotten hearts in the logs, and twisted grain, which cannot be classed as a serious and universal defect. Secondly, defects in the shape of holes and hollows caused by rot of various kinds getting into the wood. This rot is caused by various kinds of fungi and is usually started by many different agencies. Thirdly, defects caused by the attacks of insects and animals. This third class of defect is unfortunately the most universal and serious of all. The so-called bee-holes in teak timber are caused by a moth *(Duomitus ceramicus)* which lays its eggs on the bark of the teak trees of all ages. The larva or caterpillar emerges and bores tunnels 1—2 inches broad and 9—13 inches long, upwards and inwards into the wood. This pest causes great damage to teak timber both in Burma and Siam and its ravages can be clearly seen when visiting any of the teak saw-mills of Bangkok. Birds, chiefly woodpeckers, often dig holes in the timber when chasing these larvae.

(d) *Grading of Siamese Teak Timber*

There are no fixed grading rules in the Siamese teak trade, each firm exporting teak fixes its own standards. Generally speaking, exporters fix two grades for Europe squares and three grades for squares exported to other markets than Europe. Similar grades are fixed for planks and boards and smaller classes of conversions.

(d) *Distribution of Siamese Timber in the markets of the world*

Deducting the teak timber sold locally in Siam and that which is floated down the Salween River to Burma and down the Mekong River to Indo-China, it is believed that the total amount of Siamese timber exported from Bangkok yearly represents about 55% of the total annual teak production of Siam.

Nowadays transport from Bangkok takes place almost entirely by steamer.

A study of the export figures shows that great changes have taken place in recent years. Twenty years ago approximately 19%

of the Bangkok teak export went to Europe, 62.5% to India and Ceylon and only 15.5% to the Far Eastern markets.

On the average during the past few years 12% has been sent to Europe, 22% to India and Ceylon and 54% to the Far East.

The changes are due to the 15% import duties recently imposed by the Indian Governments and also to the increased development in the trade of the Chinese and Japanese markets.

Unfortunately the export teak trade to China fluctuates considerably with the political situation and the stability of that country.

The following small table shows the main results of the exports during the last two years.

Year	Total tons of 50 cubic feet each.	Average price per ton in Ticals.
1927–28	70,228.37	141.64
1928–29	76,865.03	142.26

EVERGREEN FORESTS

Evergreen forests of many different types occur over large portions of Siam. It is probable that one third of the forest area of Siam is covered by some kind of evergreen forests. Evergreen forests grow in Siam at all elevations from sea-level to the tops of the highest mountains, and in all kinds of situations and soils. Much of the evergreen forests of Siam are as yet unexploited and sometimes even unexplored. It will be convenient to divide them up into four broad classes: (A) Tropical evergreen forests, (B) Hill evergreen forests, (C) Coniferous forests, (D) Littoral and Swamp forests.

A. Tropical Evergreen Forests

These evergreen forests are of such size and complexity, and their vegetation is as yet so imperfectly known, that it must suffice to indicate their general features and the chief products which they yield.

Tropical evergreen forests grow scattered about all over Northern Siam, chiefly in damp low-lying situations near streams and rivers, they also ascend to certain altitudes, beyond which they are replaced by hill evergreen forests.

A broad belt of tropical evergreen forests separates Central from Eastern Siam.

In Eastern Siam proper they are hardly known to occur, but in the Siamese Peninsula and in South-Eastern Siam they probably constitute about 75% of the total forest area. Various types of tropical evergreen forests extend right down the Peninsula to the Federated Malay States boundary, covering the lower slopes of the axial range of mountains and the plains; while in South-Eastern Siam they cover the whole forest area except along the sea coasts and on the higher elevations of the mountains.

The general characteristics are as follows:—

An upper story of large, sometimes gigantic, evergreen trees, 100 – 200 feet in height, whose clean boles often attain a length of 60 – 80 feet. Below this a second story of smaller trees, and various kinds of palms, intermingled with many kinds of cycads, shrubs, bamboos and canes. Such forests are also very notable for many kinds of epiphytes, such as orchids and tree-ferns clinging to the stems of the larger trees. The general growth and the undergrowth are dense, often impenetrable.

The density may vary. In some parts of Siam, semi-evergreen types of forests occur, with deciduous trees mingling in with the evergreen trees.

A most prominent feature in these forests is the wide spread occurrence of the family Dipterocarpaceae, and more especially the genus *Dipterocarpus*.

The following is a short general sketch of the main sub-types occurring in Siam.

In Northern Siam the commonest sub-type contains usually a large proportion of *Dipterocarpus alatus*, *Dipterocarpus turbinatus*, *Dipterocarpus costatus* and several Hopeas especially *Hopea odorata*.

In the extreme northern portion of the Siamese Peninsula, in

Mixed Deciduous Forest of
Northern Siam.

Mai Yang Sian Forest at Ban Don,
Southern Siam.

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the Province of Ratburi, considerable stretches of semi-evergreen forests occur, in which the following are the characteristic trees: *Dalbergia sp.* (mai ching chan), *Gardenia sp.* (mai put) *Diospyros mollis* (mai maklua), *Mansonia Gagei* (mai chan), *Caesalpinia sappan* (mai fang), *Afzelia sp.* (mai maka), *Adina cordifolia* (mai kwow), *Michelia Champaca* (mai champa).

In the northern portions of the Peninsula a number of species of *Dipterocarpus* occur, together with another well known species of tree, *Cotylelobium lanceolatum.*

In the southernmost portion of Siam, in the province of Pattani, *Dipterocarpus spp.* are much less common, the most prominent tree being *Balanocarpus Heimii.*

The following species of trees are common in various parts of the tropical evergreen forests of the Siamese Peninsula: *Afzelia Bakeri* (mai lumpoh), *Fragraea fragrans* (mai tamsao), *Hopea odorata* (mai takien), *Lagerstroemia tomentosa* (mai sa lao), *Schima Noronhae* (mai mangtarn), *Mesua ferra* (mai nakbud), *Michelia Champaca* (mai champa), *Cinnamomum sp.* (mai chuang), *Artocarpus Lakoocha* (mai mahad), *Vatica grandiflora* (mai sak talay), *Calophyllum floribundum* (mai fangton), *Palaquium obovatum* (mai chiknom).

In the tropical evergreen forests of South-Eastern Siam the six most common species found are *Dipterocarpus alatus, Dipterocarpus turbinatus* (mai yang), *Lagerstroemia calyculata* (mai tabek), *Hopea odorata* (mai takien), *Anisoptera sp.* (mai krabark), *Lagerstroemia tomentosa* (mai salao).

General Economic Uses

The products of the tropical evergreen forests are of great variety and economic value.

I. TIMBER

These forests produce a great range of timbers of all sorts and descriptions. For trade purposes they may be classed as hard-woods, medium-woods and soft-woods. In Siam, as yet, little trade has been developed in the soft-woods.

Hard-woods

The most valuable hard-wood growing in Siam is that

produced by *Dalbergia cochinchinensis* (mai payung), which is one of the blackwoods or rosewoods of commerce, closely akin to *Dalbergia latifolia* of Western India. It is a fine, hard, heavy wood, deep brown to blackish in colour. It is found growing very sparsely in the evergreen forest belt between Central and Eastern Siam. It is sold by weight and is exported to China where it is celebrated as a wood for making carved Chinese furniture.

Another blackwood is *Dalbergia sp.* (mai ching chan) also celebrated for the above use. It is much commoner and of somewhat inferior colour and quality to mai payung.

The heartwood of *Diospyros mollis* produces a blackwood which is an inferior kind of ebony.

The following is a short list of well known hard-woods produced from these forests:—

Hopea odorata producing a fine durable golden-brown timber used for all kinds of purposes.

Cotylelobium lanceolatum, producing a most durable brown timber, celebrated for boat building and often exported to China for that object.

Fagraea fragrans producing a hard light-brown timber excellent for all round purposes.

Afzelia Bakeri, producing a hard heavy yellow-brown timber which is much used by the Railway for bridging and other purposes.

Lagerstroemia tomentosa, producing a good greyish-brown, moderately hard timber.

Balanocarpus Heimii produces a heavy, hard, very strong and durable, brownish-yellow timber, much prized both in the Siamese Peninsula and the Federated Malay States. In the Federated Malay States it is the standard timber of the country on account of the great value of its resin, and the felling of this species has been restricted.

Besides these there are many other valuable timbers, including some extremely decorative woods.

Medium-woods

Under the heading may be placed most of the timbers produced by the various species of *Dipterocarpus*. These timbers on

the whole are moderately hard and moderately durable, and usually pinkish or greyish brown in colour. On account of their plentifulness and of their comparative cheapness their use has much increased during recent years. They are largely exported to Bangkok, where they are extensively used in the cheaper classes of buildings. A fair foreign export of this class of timber has also been developed, to India and Ceylon, China and even to Europe.

Special woods

In this class may be mentioned *Gardenia sp.* (mai put), which greatly resembles boxwood and is used for similar purposes. It is largely exported to Japan.

Scented wood is produced by two species of trees, *Mansonia Gagei* and *Aquillaria Agallocha*; the hard-wood of this last named tree produces the well-known scented "eagle-wood". Only a small percentage of trees have the valuable scented wood, and it is often impossible to tell whether it is present or not, without felling the tree. The odour is supposed to be produced by fungoid infection. The scented woods are used for burning as incense and in perfumery.

Caesalpinia sappan possesses a hard, heavy, red-yellow wood. The wood is cut up into chips and boiled down producing a valuable commercial dye-stuff.

In connection with the extraction of timber from the tropical evergreen forests of Siam, a short description of the methods employed by the two largest Companies may be of interest.

The Sriracha Company

The headquarters and saw-mill of the Company are situated at Sriracha on the East coast of the Gulf of Siam, about 6 or 7 hours by steamer from Bangkok.

The Company is working on a 20 years lease granted by the Siamese Government in 1915. The area covered constitutes two small Provinces or Governorships. Under the terms of the lease, the Company may exploit all kind of trees above certain girths, fixed by the Government. The Company pay royalties which vary from 1½ satangs to 3 satangs per cubic foot on the contents

of round logs, with a fixed deduction for wastage.

The trees when felled and logged are dragged up to the logging tramway and loaded on the trucks by means of American ground-skidders, of which four are always in use and one in reserve.

There are two main lines of logging tramway, one running northwards and the other southwards, meeting at a junction and running on one line along the last section into the saw-mill at Sriracha. The log trains are hauled by locomotives.

There are besides a number of side-lines which are constantly being shifted. Elephants are employed to push the loaded trucks up to the main lines.

The whole of the forest operations are connected up and controlled by telephones.

The large saw-mill at Sriracha is of a modern American pattern and was constructed and organized at the beginning by American saw-mill experts.

The converted material is conveyed by truck along a jetty half a mile long and loaded into steam lighters and conveyed to Bangkok. Most of the material is consumed in Bangkok, but some portion is exported.

The chief species to be exploited are *Dipterocarpus spp.*, *Hopea odorata*, *Lagerstroemia calyculata* and *Anisoptera sp.*, besides a large number of other miscellaneous jungle-woods. About 60% of the timber is made up of *Dipterocarpus spp.*

The usual annual input into the saw-mill is from one million to one and a quarter million cubic feet in the round log. The usual annual output of converted timber is about half this amount. The usual annual revenue to the Government is about Tcs. 25,000.

The East Asiatic Company

The Danish East Asiatic Company exploits Dipterocarpus timber and also miscellaneous hard-woods in the Bandon district of the Siamese Peninsula.

The saw-mill of the Company is situated about 10 kilometres from the mouth of the Bandon River, near the east coast of the Peninsula, about 600 kilometres south of Bangkok.

The Company works on large permits, generally for 10,000 trees, granted by the Siamese Government. The rates of royalty charged vary from Ticals 1.00 to Ticals 2.00 per cubic metre in the round log. The trees to be felled are selected and marked by the Forest Department.

The Company has a narrow-gauge tram-line, about 8 kilometres long, running through the forests, with a number of side-lines.

After the trees have been felled and logged, elephants are employed both to drag the logs up to the tram-line and to load them on to the trucks.

The elephants pull the trucks along the up-grades for about half the distance ; on the down grades the trucks run down by their own weight, being controlled by men and brakes. Eventually the contents of the trucks are tipped over into a river at the end of the tram-line.

Siamese raftsmen then catch the logs in the river and make them up into rafts, which are floated down to the saw-mill in one to three days journey. For the purpose of floating these rafts, both bamboos and iron floats or pontoons are employed. The latter method is a very unusual mode of conveying timber by water.

After conversion in the saw-mill, the material is conveyed by steamer to Bangkok, where most of it is utilized, a fair proportion, however, being exported to foreign countries.

The usual annual input into the saw-mill is 500,000 cubic feet in the round log and the usual output is 285,000 cubic feet of converted material.

The species of trees exploited are *Dipterocarpus spp.*, *Cotylelobium lanceolatum* and *Afzelia Bakeri*. About 75% of the timber consists of *Dipterocarpus spp.*

II. FUEL

There is a large local consumption of fuel from many different species of trees, throughout the tropical evergreen forest.

The Southern Railway line, which runs the whole length of the Peninsula, thus connecting the Federated Malay States with Siam, now uses nothing but wood-fuel and consumes approximately 120,000 cubic metres stacked of fuel annually. It is now pro-

posed to organize some of the forests, so as to produce a regular and permanent fuel supply for the Railway.

III. BAMBOOS

Bamboos from the semi-evergreen and evergreen forests are put to all kinds of local uses. In particular, along the coasts of the Peninsula, there is local use and trade in bamboos for fishing stakes.

From the west coast of the Peninsula there is a considerable export of bamboos in small local craft to Java and Sumatra, where they are used as frames on which tobacco leaves are dried and cured.

IV. CANES

Rattan canes are spiny climbing plants belonging to seven genera, of which the genus *Calamus* is the most important.

Many kinds of canes abound all over the evergreen forests of Siam. They prefer the dampest localities and are often found growing luxuriantly in swamps or cane-brakes. They reach their greatest development in the Peninsula, where there are probably at least 40 species known, besides others as yet undetermined.

Canes grow by hooking on to and climbing up large trees. They often attain astonishing lengths and have been found up to 200 yards in length.

They are gathered by pulling them down from the trees; when collected for export, they are cut up into lengths of about 20 feet, but roughly sorted and graded and made up into bundles of 100 each.

There is considerable export of canes from the Peninsula by water and by rail, chiefly to Singapore, which is a great emporium for canes from many different countries.

Canes are used for walking-sticks and also in the manufacture of furniture, baskets, mats, mattresses and corsets. In Siam they are also put to many other local uses.

V. GUMS, OILS, RESINS

(a) *Gums*

Gutta-percha is a gum which has the property of being the best non-conductor known for both heat and electricity. It looks

like rubber, but it lacks elasticity and becomes plastic on heating. It has great value commercially for the coating of submarine cables. It is much used for other purposes also, especially in the manufacture of golf-balls. The gutta percha of Siam is known as "white gutta" commercially, and is produced from the latex of an evergreen tree, *Palaquium obovatum*. This tree occurs sparsely in some of the evergreen forests of Pattani Province in the extreme South of the Peninsula, in Chantabun Province in South-Eastern Siam, and notably in the island of Kaw Chang, situated on the south-eastern coast. In Siam the tree is tapped by making a long spiral cut, which starts from the base of the trunk and gradually ascends the tree. The tapper climbs the tree by tying cross bars to the trunk. A bamboo joint, placed at the foot of the trunk, receives the latex. White gutta is mostly exported from Bangkok and the price varies from Tcs. 40/– to Tcs. 50/– per picul (133⅓ lbs).

The valuable gum known as *gum benjamin* or *gum benzoin* is produced by tapping various species of tree of the genus *Styrax*. At present little is known in Siam about the various species of trees producing this gum, but a sample of gum benzoin taken from the evergreen forests of the Chiengrai Province in North-Eastern Siam has given excellent results. In 1928-29, 256 piculs of gum benzoin valued at Tcs. 50,531 were exported from Bangkok.

(b) *Wood-Oils*

The various species of the genus *Dipterocarpus* produce thick viscous wood-oils. Both the quality of the oil and the quantity produced vary a good deal according to the particular species.

This wood-oil has great economic value and there is a widespread minor industry connected with it, all over the tropical evergreen tracts of Siam, wherever suitable species of *Dipterocarpus* occur.

This minor industry really plays a great part in the economic life of the poorer classes, who are able thus to earn money during the slack seasons of the year when they have little else to do. The trees are tapped on permits, the size allowable for tap-

ping being 2 meters 50 centimeters in girth and above. In tapping the tree a hole, roughly semi-circular in shape, is scooped out of the trunk. The dimensions of the hole are approximately 4 inches or 10 cm. wide, 1 foot or 30 cm. long and 8 inches or 20 cm. deep. The base of the hole is slightly concave like a shallow basin.

Immediately after the hole is made, oil gradually drips out and fills the "basin". In 3 or 4 days it is full and the tapper bales out the contents into a kerosin-oil tin.

After every collection the hole is cleaned out and filled with dry grass, leaves and such like combustible material, which is fired. This firing stimulates the further flow of oil. The same hole may be used up to 3 years, after which another hole is made generally on the opposite of the tree. When the lower part of the tree trunk is worked out, tapping may be continued higher up, by means of ladders. Of course the damage done to the tree itself is considerable.

This industry is highly developed in Southern and South-Eastern Siam. The oil is used for water-proofing bamboo and canework, for caulking boats and for impregnating torches. The price of this yang oil, as it is called, is Tcs. 3½ per tin; the price of torches varies according to size. Much oil is exported to Bangkok, Penang and Singapore from various parts of Siam.

In 1928-9, 96,902 tins of yang oil and 363,082 bundles of torches passed through the Forest Revenue stations in the Peninsula. 430,631 yang trees were tapped on permit in the Peninsula in the year 1928-9, and it is estimated that 50,000 trees at least were tapped on the Western coasts, without permits, in areas where the tapping rules are not enforced.

In certain swampy low-lying parts of the Peninsula, a small- to medium-sized tree called *Melaleuca Leucadendron* grows over extensive areas. It produces a greenish coloured oil known to commerce and medicine as cajaput oil. This oil is distilled from the leaves of the tree. The oil has properties resembling eucalyptus oil and is used both in local and European medicine.

(c) *Resins*

Gamboge is a bright yellow resin of considerable commercial value for various purposes, especially as a colouring agent. It is obtained by tapping an evergreen tree called *Garcinia Hanburyii*. This tree occurs sparsely in the Southern part of the Peninsula, in South-Eastern Siam and in the island of Kaw Chang.

In 1928-29, 305 piculs weight of gamboge was exported from Bangkok with a total value of Tcs. 60,523.

Dammar is the valuable gum produced by two species of trees belonging to the Dipterocarp family: viz. *Balanocarpus maximus* and *Balanocarpus Heimii*, which are known under their respective Malay names of Chenga Mas and Chenga Batu.

These trees are large fine evergreens, occurring principally on slopes of mountain ranges in Southern Siam. They are found in great number in the Circle of Pattani where they are tapped for dammar. Old and over matured trees yielding no dammar are cut down for their beautiful and hard timber, which is much prized for furniture and building purposes.

The tapping of dammar is regulated by Rules issued by the Minister of Agriculture, and is under the control of the Forest Department. These Rules are enforced only in the Circle of Pattani, in other districts tapping is not permitted. The tapping is allowed on permits for which the tappers have to pay a fee of Satangs 25 per year for each tree permitted to be tapped. The minimum tappable size of the tree is 200 c.m. in girth at 75 cm. from the ground. The size of the cut or tapping holes not to exceed 10 cm. in length and breadth and 5 cm. in depth. The distance between the cuts or holes must not be less than 30 cm.; however, the number of cuts or holes made varies not only with the size of the trees but also according to the yielding capacity of each individual tree; fifty to sixty is a fair average number, but in trees of vigorous growth larger number of cuts or holes may be made, these may extend right up to the branch in the crown of the tree.

The dammar exudes in tears all over the cut and is allowed to stay till it becomes thoroughly crystallized: the longer the gum is left to dry, the better will be the quality of the dammar, but as

a rule 4 months is considered the proper period for its maturity. On account of the prevalence of theft of gum on trees, the tapper is often forced to collect it at the end of six or eight weeks, the resultant product is a low grade dammar. After each collection, the tapper freshens up the cuts and the process continues until the exudation ceases, when fresh cuts or holes are made and the old ones left to heal over.

When tapping, the tapper climbs up the trees by having his feet in the two lower cuts or holes and a rattan climbing-sling round his body and round the bole of the tree. He works all up the tree raising himself with the sling and using his hand and feet in the cuts or holes. A bamboo basket is tied at his waist to serve as receptacle for the gum collected. A good tapper can tap two to three trees a day, working from early morning to noon, and earning Tcs. 400-600 a year.

The average annual yield of dammar is about 1/3 picul or about 45 lbs. per tree, the average total annual output for the whole circle is about 10,000 piculs. The price varies according to quality of gum and ranges from Tcs. 20/–to Tcs. 40/–per picul.

The tapper sells his product to the Chinese middlemen who export the same to Singapore, where it is graded and prepared for the European market.

The revenue derived from this source amounts to Tcs. 32,000, consisting of permit fees and export duty at 10% of the value of the dammar.

B. Hill Evergreen Forests

This type of forest is found all over Siam on hills and mountains at an elevation of 3,000 feet and upwards. As a rule they are thick impenetrable evergreen forests. They are little known and explored as yet. They have practically no commercial nor economic value at present.

C. Coniferous Forests

Coniferous forests are found all over Northern and Central Siam at elevation from 2,000—5,000 feet, and occasionally beyond this latter limit. They do not occur in the Peninsula nor in South-Eastern Siam. The growing stock in these forests is composed

mainly of two species of *Pinus, Pinus Khasya* and *Pinus Merkusii.*

These forests have little or no commercial value at present. The local people do a little resin-tapping in places for their own use and also manufacture torches from the resin-impregnated wood of the pine trees.

D. Littoral and Swamp Forests

The main characteristics of these forests are that they are coastal strips of thick muddy tidal swamps, intersected by many waterways, forming what are known as mangrove swamp forests.

Mangrove swamps are found in parts of Siam, Southern Burma, F.M.S., Borneo., the coast of Africa. They are well known in the Philippine Islands.

In Siam mangrove swamps occur in small patches at the mouth of the Menam Chao Phya river and on the east coast in the Peninsula. A large and more compact area of mangrove swamps is situated at the mouth of the Menam Wen River, in the Chantabun Province in South-Eastern Siam, whilst much the largest and most valuable mangrove areas occur at intervals, wherever the coasts are muddy, along the whole of the western coast of the Siamese Peninsula, a distance of 500 kilometres (300 miles) from the southernmost point of Burma to the Federated Malay States boundary. It has been roughly estimated that the area of these mangrove swamps covers 300,000 acres.

Under the peculiar conditions already indicated, only a limited number of species can thrive in mangrove swamps, and most of these trees are endowed by nature with peculiar structures enabling them to flourish in these surroundings. Of these structures one of the most noticeable is the tangled mass of roots which appear above the ground-face in mangrove swamps. These roots, which are known collectively as air-roots or pneumatophores, have a spongy texture which absorbs air and thus serves to aerate the root systems of the trees. They assume many different forms.

These swamps are all tidal, and at high tides considerable portions of the trees are under water. The most important and

typical trees in the mangrove swamp forests belong to the family Rhizophoraceae, to which the true mangroves belong.

The members of this family are distinguished at once from all others by the fact that the seed germinates and produces an elongated seedling known as the hypocotyl, before the fruit drops from the tree. Eventually this seedling drops like a dart into the mud, where it remains upright and starts growing and developing into the young tree.

In this family the genus *Rhizophora* stands out from all others, by the fact that the trees of the various species which compose it grow up in the air, so to speak, on peculiar stilt or prop-roots, The base of the trunk of a large tree will thus be 3-6 feet (1-2 metres) above the ground, with the roots all round it, like props, supporting the trunk.

This genus is represented in the Siamese mangrove forests by two species, *Rhizophora mucronata* and *Rhizophora conjugata* (mai sangka bai yai and mai sangka bai lek). These species form medium-sized trees up to 3 feet or 1 metre in girth and up to 40 feet in height, gregarious in habit.

The next important genus in this family is *Bruguiera*, represented by three species, of which *Bruguiera gymnorhiza* (mai pangka hua som) is the most important. The trees of this genus grow to considerably larger dimensions; they are not gregarious in habit, and do not develop stilt-roots.

The last genus of the tree mangroves, *Ceriops*, is represented in these forests by *Ceriops Candolleana* (mai samê), a tree which attains sometimes 65 feet or 20 metres in height and more than 39 inches or 1 metre in girth. It grows gregariously but does not produce stilt roots.

Most of the Rhizophoraceae family produce also aerial roots, which drop down from the side-branches and thus anchor the trees in the ground. The general effect of the peculiar root-systems is altogether very curious and characteristic.

There are a few other important species of trees growing in these mangrove forests, belonging to other families: of these the most important are *Carapa moluccensis* (mai tabun dam), *Carapa*

obovata (mai tabun kao) and *Lumnitzera coccinea* (mai tamsao nu), none of which develop stilt roots.

There are also a few species of trees, common to these forests, but of no value, of which the most common are *Avicennia spp.* (mai api-api), *Sonneratia acida* (mai lampu), *Excoecaria Agallocha* (mai tatum).

The well-known palm, *Nipa fruticans*, the attap or nipa palm, is very wide-spread, growing throughout these forests, usually as a thin fringe along the water's edge.

General Economic Uses

Considering their relatively small area, the general economic value of the Siamese mangrove forests is very great, and their economic products are of considerable variety. In the areas where they occur, it is probably that 5 to 10% of the local population are engaged in exploiting and trading in the mangrove forest products.

TIMBER

Both *Rhizophora mucronata* and *Rhizophora conjugata* produce small to medium-sized timber, which is hard and heavy and extensively used for fishing stakes and house-posts.

The timber of *Ceriops Candolleana* is yellowish, hard, close-grained and very durable; it is put to all kinds of uses. *Carapa moluccensis* and *Carapa obovata* produce good serviceable timber. The wood is hard, durable, and takes a good polish. When freshly cut, it is purplish in colour, but turns a fine dark red-brown colour on seasoning. It is much in demand for furniture and house building.

FUEL AND CHARCOAL

It is in fuel and charcoal that the trade reaches its greatest development in Siam.

On the west coast of the Peninsula, these industries are in the hands both of Chinese and of the local Siamese and Malays. The trees are felled and brought back in boats to the fuel or charcoal-making camps. There the wood is sown into lengths of of 4 feet 3 inches (2.30 metres) and split for fuel billets.

For the preparation of charcoal, large circular kilns built of

burnt or unburnt bricks are constructed, holding from 48 to 55 cubic metres stacked, of various mangrove woods.

The resulting charcoal is of excellent quality, and, when ready, is packed for export into neat bamboo baskets.

From the southern portions of these coastal forest all this fuel and charcoal is exported direct to Penang city, in large Chinese junks, which are able to sail up the large creeks right into the forests and load there.

In the northern portions of these forests, in and around Puket Island, there is an extensive and old established tin-mining industry. The mangrove forests in those parts are most useful in supplying the labour force of the mines with fuel, and the large tin-dredges are driven entirely either by mangrove fuel or charcoal. The fuel and charcoal exported from the mangrove forests on the east coast of the Peninsula and that of the south-eastern mangrove forests are despatched to Bangkok by local craft and sometimes by steamer, to be sold and consumed in Bangkok city.

MANGROVE BARKS

All the different species of *Rhizophora*, *Bruguiera* and *Ceriops* produce excellent barks, from which mangrove cutch is extracted, which is very valuable for tanning and dyeing purposes. In particular the bark of *Ceriops Candolleana* is well-known for the red-colouring matter which it contains.

These barks are stripped from the trees, made up into bundles and exported, chiefly to Singapore and China, whence they are distributed all over the world.

THE NIPA OR ATTAP PALM

The chief local use for the leaves of the attap palm is for making roof-shingles. The manufacture of proof-alcohol from the juice of the inflorescence stalk, which has attained such great importance in the Philippine Islands, has not yet been started in Siam.

STATISTICS OF PUKET FOREST DIVISION

The Puket Forest Division includes the whole of the mangrove forests situated on the west coast of the Peninsula, by far the largest and most valuable areas in Siam. The following

amounts of fuel, charcoal and tanning barks were extracted by purchasers in the year 1928-29.

Fuel	...	264,113 cubic metres.
Charcoal	...	56,415 cubic metres.
Bark	...	108,384 piculs weight.

OTHER-WOODS FORESTS

Forests in Siam, situated outside the teak-bearing forests, are generally referred to by the general term of other-woods forests. They are of great extent and variety, covering, as they do, more than half the total area of the country, outside the teak forests.

Government Control

Government control over these forests is based on the Royal Decree for the protection of forests, together with the Rules and Regulations emanating from it. This Decree was passed in 1913-1914. Under this authority other-woods trees are divided into two divisions (1) Unreserved Trees and (2) Reserved Trees.

Anyone can fell and use unreserved trees. In the Reserved Division, trees are divided into 3 classes (1) very valuable trees which may not be felled at all (2) valuable kinds of trees, (3) less valuable kinds of trees.

Minimum exploitable girths are fixed for the various reserved species, under which no tree may be felled.

Anyone wishing to fell and use reserved trees of classes (2) and (3) must take out a permit and pay fees fixed by Government. This also applies to other kinds of forest produce other than timber produced by these trees. Free permits are also issued for various objects.

This Royal Decree extends over most parts of Siam now, but not everywhere. In the distant portions where there is no trade in forest products, it has not yet been enforced.

The species of trees notified under this law vary according to the localities and to local circumstances.

Exploitation

(a) *General*

The lease system is not developed greatly as in Northern Siam. There are, however, several small leases in force in

Eastern Siam, two larger leases in South-Eastern Siam, and one lease in operation in the northernmost portion of the Siamese Peninsula. In general, exploitation is done under permit. Permits vary greatly, the largest being issued for 10,000 trees and the smallest down to 1 or 2 trees.

(b) *Extraction*

Extraction varies greatly. On the coasts or near waterways, extraction is often done by boats or by rafting, if the timbers will float. Overland extraction is done generally by carting, with buffaloes or bullocks. Buffaloes are usually employed for dragging and sometimes elephants, but outside Northern Siam the use of elephants in working out timber is not so general. The two largest companies operating employ mechanical methods of transport.

Deciduous Forests

The deciduous forests occupy large areas in Northern Siam and Central Siam, most of the forest-clad areas in Eastern Siam, and they extend to South-Western Siam, that is to say, the Northern portions of the Siamese Peninsula.

They do not occur in the Southern Peninsula forests nor in the south-eastern forests, which lie on the eastern side of the Gulf of Siam. This vast and wide spread forest area has a great similarity in general type throughout, this similarity being due to the same soil conditions. But the soil does vary in parts and with this soil-variation the vegetation often changes, thus producing a great variety of sub-types.

These forests will be dealt with according to their geographical situation.

Deciduous Other-Woods Forests situated In Northern and Central Siam

In Northern Siam it has been estimated that at least half the forest-clad area in this portion of Siam is covered with these dry deciduous non-teak bearing forests. These forests are known locally as pah peh or pah deng. They occur both on the level plains, on low foot hills, and they sometimes cover steep hills up to a height of 4,000 feet. The general appearance of these forests is open, grassy, often approaching the savannah types

of forests; the trees are scattered, and as a general rule of medium or small size, both in height and girth.

These forests grow on porous well-drainsd soils, which are generally formed by the decomposition of laterite. These soils are either red-clay, reddish or pinkish loams, reddish or white sandy soil and sometimes of poor rocky composition.

Undergrowth consists of long grass or scattered bushes. These forests are burnt regularly every year, nevertheless natural regeneration occurs fairly plentifully and often luxuriantly. The seedlings and young trees are burnt back every year, but they recover and after a few years establish themselves and become part of the forest crop.

The following are the main sub-types recognizable, although, as previously stated, these sub-types intermingle and form all kinds of mixtures.

I. MAI TEUNG JUNGLE

In this sub-type *Dipterocarpus tuberculatus* (mai teung) is the commonest and dominant tree. This tree is the largest of the common trees found in these forests, growing sometimes up to 80-90 feet high and 8 feet in girth. It reproduces freely from both seed and coppice, and has the property of growing in pure stands. Large stretches of young regeneration of this species may often be seen, forming dense crops. It often grows in a mixture with *Dipterocarpus obtusifolius* (mai hieng).

Many other species of trees grow in this sub-type and the following are the commonest, *Dipterocarpus obtusifolius* (mai hieng), *Shorea obtusa* (mai ngaa or mai teng), *Pentacme siamensis* (mai sau or mai rang), *Terminalia tomentosa* (mai hok fa), *Buchanania latifolia*, *Melanorrhea usitata* (mai rak or mai hak), *Careya arborea*, *Dillenia spp.*, *Quercus sp.*, *Gardenia erythroclada*. The undergrowth in these forests consists of grass, bushes, and sometimes dwarf palms and cycads.

II. MAI HIENG JUNGLE

This sub-type resembles considerably the sub-type just described, with this difference that *Dipterocarpus obtusifolius* is the common and dominant species of tree.

As a rule also it prefers the more sandy and loamy soils to the stiffer red clays. The dominant tree, *Dipterocarpus obtusifolius*, is also one of the largest trees, attaining sometimes 70-80 feet in height and 6 feet in girth.

It has many of the characteristics of *Dipterocarpus tuberculatus*, in that it reproduces freely from seed and coppices and often forms pure crops. It is also found in varying mixtures, its common associates being the trees already mentioned.

III. MAI PAU AND MAI NGAA JUNGLE

These two sub-types are so alike and so inter-mixed that it is impossible to distinguish them. They occur both on plains and on low stoney hills. Generally the soil is dry, stony and rocky, and usually, the redder and more lateritic is the composition of the soil, the more these two species *Shorea obtusa* and *Pentacme siamensis*, will be found.

Owing to the poverty and dryness of the soil, the development of these two trees is usually medium or small, and sometimes on rocky situations it is bushy and stunted. The general height of these sub-types of forests does not exceed 50 feet and girths are usually up to 4-5 feet. These sub-types are usually termed "pole" and even "scrub" forests. These sub-types will be found slightly intermingling in places with other sub-types and their common associates are also much the same.

IV. MISCELLANEOUS DRY FORESTS

In certain localities miscellaneous dry forests occur which are chiefly notable for the growth of various thorny Acacias, of these the most prominent are *Acacia catechu*, *Acacia leucophloea* and *Acacia Farnesiana*.

Dry Deciduous Forests in Central Siam

Large areas of forests of similar composition to those already described occur in parts of Central Siam. The only great noticeable difference observed is the prevalence of large stretches of pure or practically pure *Terminalia tomentosa*.

General Economic Use

The construction of the Railway through Northern Siam to Chiengmai has greatly increased the general economic value of

these dry deciduous forests.

Both *Shorea obtusa* and *Pentacme siamensis* produce hard, heavy durable red-brown timber, as good as the celebrated sal timber of Northern India.

Most of the timber used by the Railway Authorities for telegraph posts, bridge timbers and sleepers is derived from these two species of trees and, moreover, there is great local trade and use of these two timbers, for house-building and house posts especially.

Dipterocarpus tuberculatus is also used as timber, especially when sawn into planks; when protected it is fairly durable, but does not last so well when exposed to the weather.

As the Railway runs entirely on wood fuel, the question of fuel supply is very important. Both *Dipterocarpus tuberculatus* and *Dipterocarpus obtusifolius* produce excellent fuel, and large quantities of good fuel are also obtained from *Shorea obtusa* and *Pentacme siamensis*, whenever they are unsuitable for conversion into timber.

The wood oil of *Dipterocarpus tuberculatus* is largely tapped locally and, being mixed with the resins of *Shorea obtusa* and *Pentacme siamensis* and other substances, is used for caulking boats and water-proofing bamboo-work.

The resin of *Melanorrhea usitata* produces a varnish used in the manufacture of lacquer-work articles, and there is a flourishing industry of this nature in Chiengmai town, with an annual out-turn estimated to be worth Ticals 100,000. The leaves of various species are used for thatching, and there are also many other local minor uses of these trees, such as medicine. The dark red wood of *Acacia catechu*, when cut into small chips and boiled down, produces the valuable commodity known as "cutch".

Dry Deciduous Forests in South-Western Siam

In the Ratburi District, situated in the South-Western corner of Siam there are extensive dry deciduous forests. These forests lie at the north of the Peninsula, between the southern railway line and the high western watershed, separating Siam from Burma. These forests extend from the plains to the lower

broken hills, until, in the higher elevation, they are replaced by evergreen forests.

In general the soil is of red lateritic composition, and the forests do not differ essentially from the types already described. They are of great economic value locally for house-building, and vast numbers of house posts are extracted from them and despatched annually to Bangkok by water and by rail.

Dry Deciduous Forests in Eastern Siam

GENERAL

Eastern Siam is a large undulating plateau, approximately 65,000 square miles in area. It is watered by two large rivers flowing into the Me Kong River, which forms the eastern boundary of Siam for about 500 miles. But, the general conditions of climate and soil are dry, in fact taken as a whole it is one of the driest parts of Siam, depending largely for cultivation on rainfall and not on irrigation.

The underlying rock is usually a soft yellowish sandstone intermingled with various kinds of shales, with extensive outcrops and occurrences of laterite, here and there. The soils varies a good deal from pure sands to yellowish loams, intermingled with soils derived from lateritic sources, reddish and pinkish in colour.

It is probable that two-thirds of this eastern part of Siam is covered with forest-growth of a dry deciduous nature. Until recent years, these tracts were so remote and so difficult of access that a good deal of this forest is as yet unexplored and undeveloped.

On the western slopes of the main plateau there runs a broad belt of evergreen forest known as the Dong Phya Fai.

DESCRIPTION OF FORESTS

The forests have many features in common with the sub-types of the dry deciduous forests already described in other parts of Siam but with various additions.

Wherever the soil forms a deep loam, these forests constitute as fine crops of this type as can be found in the whole of Siam. Wherever the soil is dry and shallow with rocky outcrops of laterite, the growth and quality decrease correspondingly.

It has been estimated that, on the average, about 50% of the crop consists of *Shorea obtusa* and *Pentacme siamensis*, about 20% of *Dipterocarpus obtusifolius*; about 3% *of Adina cordifola ;* about 4% of *Xylia dolabriformis*; about 4% of *Pterocarpus indicus*; about 2% of *Sindora siamensis;* and 17% of other miscellaneous species.

The most important auxillary species are *Garuga pinnata, Albizzia Lebbek, Schleichera trijuga, Lagerstroemia floribunda, Odina Wodier, Terminalia tomentosa, Terminalia belerica, Terminalia chebula, Phyllanthus Emblica, Bombax insigne, Vitex limonifolia, Afzelia xylocarpa, Cassia Garrettiana, Dalbergia spp.*

In a few damp localities, on the banks of streams, the forests sometimes change into a more evergreen character but this is distinctly uncommon.

The general appearance and the undergrowth of these forests are characteristic, and have already been described. These forests are burnt annually.

General Economic Uses

The construction of the North-Eastern Railway line to Korat and its present extension right through Eastern Siam to meet eventually the frontier of Indo-China, have already wrought considerable changes in that part of the country.

Owing to the long railway journey, it has not yet been found possible to develop any great and permanent export trade in forest products, but the Railway itself has become a great user of the local timber and fuel.

The Railway has used and is using large quantities of timber of *Shorea obtusa, Pentacme siamensis* and *Xylia dolabriformis* for sleepers, bridge timbers and general constructional purposes. An increasing local trade in these timbers is being developed.

The timber of *Dipterocarpus tuberculatus* and *Dipterocarpus obtusifolius* is extracted in the round and sawn up locally for planks. The timber of *Pterocarpus indicus,* producing a fine hard red-brown wood, and that of *Adina cordifolia,* producing a very regular yellowish wood of medium quality, are now also

sometimes exported to Bangkok by rail.

As the whole of the North-Eastern Railway line runs entirely on wood fuel, the fuel supplies derived from these forests are of great importance, and it is to be hoped that the forests will soon be organized to produce a permanent and regular supply of railway fuel. Minor forest products of the kinds already described are also largely extracted and locally used.

CHAPTER IX

AQUATIC RESOURCES AND FISHERIES

General Importance of the Fisheries

From early times fish has been a prominent element in the dietary of the Siamese. In recent years fish has been the most important animal food of the people, and, with rice and fruit, has afforded a cheap, well-balanced ration. At the present time some kind of water product is eaten daily in every Siamese household.

The fisheries rank next to agriculture in extent and value among the basic industries of the country, and have a three-fold importance, as the source of an indispensable food, as the means of livelihood for a large proportion of the population, and as a source of revenue to the government. In the absence of a census, the full extent of the industry is unknown, but the annual production has been estimated to be worth 25,000,000 ticals.

Fishing Grounds

Siam's marine fishing grounds comprise about three-fourths of the shore waters of the Gulf of Siam and a long section of the eastern shore of the Indian Ocean between Burma and Malaya, the total length of the coast line being over 2,500 kilometres. The Gulf of Siam is 350 kilometres wide at its constricted mouth and 800 kilometres in maximum length. These waters abound

with useful products which are extensively sought, for local use and for export. The Gulf of Siam is so shallow that all parts of it are available for fish life, but the fisheries there, as on the west side of Peninsular Siam, are confined to a narrow coastal belt.

Siam's fresh-water fishing grounds include many large interior rivers, of which those in central Siam form, with innumerable canals, an extensive net-work, many lakes and swamps, and boundary streams of large volume, in all of which valuable fishes occur.

Fresh-Water Fishes

The fresh waters of Siam produce fishes in great variety and abundance, possessing high food value and excellent flavor. Some are peculiar to Siam, others have a wide range extending from China to India and throughout the Malay Archipelago. Some of the fishes have peculiar habits which have made them celebrated throughout the world, such as the climbing-fish, the fighting-fish, and the shooting-fish. Many have a special respiratory apparatus by means of which they can breathe atmospheric air and are thus enabled to withstand the protracted drought and drying-up of waters to which parts of Siam are subject, common examples of such fishes being the serpent-heads or murrels, the climbing-fish already referred to, and one family of cat-fishes.

The fishes that are most numerous as to both species and individuals are the members of the great carp family (Cyprinidae), although the true carp, native of China and very successfully introduced into Europe and America, does not occur in Siam.

Some representatives of the family occur wherever there is sufficient water to support fish life, and are to be found in the catch of every kind of apparatus and in the supply of every market throughout the country. Some of the species are quite small, not exceeding a length of 4 to 5 centimetres when full grown, others are comparatively large, and at least one reaches a length of 2.5 metres. The most important genera are *Puntius* (pla tapien, pla soi, etc.,) *Osteochilus* (pla prom), *Dangila* (pla sa, pla soi nok kao), *Cyclocheilichthys* (pla takok, pla nam lang), *Cirrhina* (pla nuan chan), *Hampala* (pla kasub), *Thynnichthys*

Seine fishing on an interior stream.

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(pla klet tee), *Luciosoma* (pla ai ao), *Culter* (pla tong plu), and *Catla* (pla kaho).

Next in importance comes the group known as cat-fishes, which in Siam fall into seven families and comprise a large number of species some of which are widely distributed, very abundant, highly esteemed, and consumed in enormous quantities. There is a wide range in size, several kinds being less than 10 centimetres in length, while the colossal "pla buk" of the Mekong basin is reported to become as large as a water buffalo and is known to reach a length of 3 metres. Among the Siamese cat-fishes are many species, belonging to several genera, which have the interesting habit of oral incubation, that is, the eggs, which are relatively few in number but very large (up to 1.5 centimetres in diameter), are taken into the mouth of the male immediately after being laid and are there retained during the entire period of hatching, and even after hatching the young remain in the male's mouth until the yolk-sac is completely absorbed and they are able to swim freely. During the period of six weeks or longer, while the male parent is performing this unusual duty, he is obliged to abstain from all food and in consequence becomes greatly emaciated.

The murrels, or serpent-heads, are a strikingly-marked family (Ophicephalidae), with greatly elongated bodies, large heads, large mouths, and long dorsal and anal fins. They are fishes of sluggish habits, live in sluggish waters with muddy bottom, and are able to lie buried in the mud for protracted periods. Of the six species found in Siam, two attain a length of a metre. Exceedingly large quantities are caught and consumed in all parts of the country, and they may be considered staple products in most sections. Owing to their ability to live out of water for many hours, they are always exposed for sale in the markets in a live condition. The flesh of the commonest species, pla chon (*Ophicephalus striatus*), is excellent either fresh or dried.

The family of hair-fins (Osphronemidae) contains the celebrated gouramy, which attains a large size but is not abundant in Siam, and several members of the genus *Trichogaster* or

Trichopodus, of which the best is "pla salid," very extensively dried for local use and for export. These are fishes of sluggish waters and are adapted for cultivation in ponds.

Other common fresh-water market fishes are two species of feather-backs (*Notopterus*), locally known as "pla chalat" and "pla krai"; the climbling-perch or "pla maw" (*Anabas*); a large eel, "pla lai" (*Pisoödonophis*); thread-fins, "pla nuad pram" (*Polynemus*); several soles, "pla lin ma" and "pla lin kwai" (*Cynoglossus* and *Synaptura*); and a number of gobies, "pla bu," including the largest member of this cosmopolitan group.

There are two valuable migratory fishes that spend most of their life at sea and at times run into the lower courses of some of the rivers. One of these, a bass, "pla kapong" (*Lates*), attains a weight of 20 kilograms or more and is one of the best and most of popular of the local food fishes. The other is a shad, "pla talum puk" (*Hilsa*), a large member of the herring family, which supports a special net fishery at Bangkok and elsewhere, and its flesh and roe are in great demand.

Marine Fishes

The coastal waters of Siam are resorted to by vast numbers of fishes, among them being some of the best and commercially most valuable fishes of tropical seas. Some of them are wide roamers, and individuals may in the course of a year come under several national jurisdictions; some free-swimming forms have definite and regular migrations which are affected by, or coincide with, the monsoons; some shore and bottom species are more or less sedentary, or at least undergo no extensive migrations. Important economic fishes belong in each of these categories.

The world-wide group of herring-like fishes is well represented in Siam by many genera and species, some of which attain great abundance and are of importance because of the present or prospective uses that may be made of them. Among the more conspicuous forms are those known to the Siamese as "pla lang kio" and "pla ok kalae" (*Clupea*), "pla luk kluey" (*Dussumieria*), "pla put," "pla lek," and "pla taluek" (*Pellona*), "pla kok" (*Anodontostoma*), and "pla dab lao" (*Chirocentrus*).

View in a slat trap on an interior river.

Gathering oysters from rocks at low tide.

Another group conspicuous for its numbers and for its prospective as well as its present economic value is the anchovies (Engraulidae). Many kinds of anchovies proper (*Engraulis*), mostly called "pla meo" or cat-fish in allusion to the long whisker-like bristles on the upper jaw, frequent the shore waters at times; some attain a large size and all of them have a probable future utility that will prove superior to the uses to which they are now largely put. The small, slender, semitranslucent anchovies with a silvery lateral band (*Stolephorus*), called "pla kluey," occur abundantly in a number of species and are now extensively imported into Siam in a preserved condition under the name of macassar fish or red fish.

The mackerel family, which is represented in all parts of the world in temperate and tropical waters, in Siam has many important members. Among these are three or more species of Spanish mackerel, "pla insi" (*Cybium*), and two mackerels, "pla lang" and "pla tu" (*Scomber*), the last being the most valuable of the marine fishes of Siam.

Other kinds of marine fishes that are prominent in the catch and in the market supplies, are mullets, "pla kabok" (*Mugil*), in great abundance and of many species; barracudas, "pla nam dogmai" and "pla sark" (*Sphyraena*); thread-fins, "pla kurao" (*Polynemus*), some reaching a length of a metre or more; pomfrets, "pla chalamet" (*Stromateus*); many kinds of drums (Sciaenidae), called "pla chuet" and "pla ma"; groupers, "pla tukae" and "pla karang" (*Epinephelus*), and other members of the bass family (Serranidae); crevalles (*Caranx*) of many species, with local names such as "pla sikun," "pla lang kiew," "pla hang keng," etc., which at times appear in incredible numbers; various soles, "pla lin ma" (*Synaptura, Cynoglossus,* etc.), and other flatfishes; cat-fishes, "pla kot" and "pla tukang" (*Arius*); together with sharks, "pla chalam," rays, "pla kaben," and sawfishes, "pla chanak," and hundreds of other species.

Mollusks and Crustaceans

The shell-fish resources of Siam are abundant, varied, and economically important.

Among a large variety of mollusks used for food a few stand

out prominently at present. Chief among them are sea mussels, "hoi mangpu" and "hoi kapong" (*Mytilus* and *Modiola*), which grow in dense masses about the shores and are extensively gathered as food for human beings and domestic animals. At numerous places where the density of the sea water is lowered by the discharge of streams, oysters, "hoi nang rom" (*Ostrea*), grow luxuriantly and acquire a good shape and excellent flavor, but their size when they are gathered for the very limited demand is usually so large that the meat is likely to be rather tough.

Pearls of good lustre are found in several kinds of marine and fresh-water shells, but none of large size and great brilliance have been obtained. A number of species of sea shells have a pearly nacre in white or iridescent colors suitable for buttons, inlay work, and other purposes. The window-pane shell (*Placuna*), extensively used in the Philippine Islands, is abundant in Siamese waters but is not utilized.

Squids, cuttles, and octopods, known under the general name of "pla muk" or ink fish, abound and are taken incidentally in the general fisheries and are consumed locally or sent to the markets.

Shipworms or teredoes, "prieng", are eaten rather extensively on some parts of the coast, and in at least one section (South-eastern Siam) these destructive mollusks, which do immense damage to submerged timbers in all temperate and tropical waters, are cultivated for food.

Crabs, "pu" abound everywhere on the coasts: swimming crabs, mud crabs, hermit crabs, land crabs, and other kinds. The large, tasty sea crab, "pu tale" (*Scylla serrata*,) is the most extensively sought and is seen daily in the markets, securely bound to prevent the use of its powerful claws. Another common species much used for human food is the swimming crab, *Portunus pelagicus*.

Shrimps, "kung", occur in extraordinary variety and abundance on all the coasts and in the lower courses of the larger rivers, and far outrank all other kinds of crustaceans. Probably in no other country do shrimps exist in greater profusion. Forms

A fishing village (Gulf of Siam).

A fish-drying plant (Gulf of Siam).

which are extensively caught and used for food in a fresh or dried condition belong in the genera *Peneus*, *Palaemon*, *Crangon*, etc. The smallest kinds of shrimps, "kung kuey" only 1 to 2 cm. long, are very extensively gathered for making into a popular food paste known as kapi. Of the resources of the fresh waters other than fishes, the chief are large, blue-legged prawns, "kung kam kram" (*Macrobrachium*). These are caught in large numbers and are acceptable substitutes for the northern lobster in both size and flavor.

Reptiles and Batrachians

The most valuable animal in these classes is the green sea turtle "tao tanu" (*Chelonia mydas*), which resorts to sandy beaches, usually on islands, for the purpose of laying eggs. The eggs are highly esteemed as food, and the privilege of gathering and selling the eggs is granted by the government to private persons on the payment of a stipulated annual rental. In the seas of Siam there occurs the hawk's-bill turtle "kra" (*Chelonia imbricata*), which yields the valuable tortoise-shell of commerce.

There is a great abundance of frogs, some attaining a large size. The kind called "kob" is widely eaten and often exposed for sale in the Bangkok and other markets during the rainy season; the hind legs are highly prized by the Siamese, as by the people of other countries.

Large water lizards or monitors, "hia" (*Varanus*), frequent rivers and swamps, and there is a limited trade in their skins, while their flesh is eaten in the country districts and their eggs are used as food.

Crocodiles, "choraké," of two species, abound in both fresh and salt waters; and although their hides are valuable and may be made into an attractive and durable leather, no commercial use is at present made of these creatures.

Interior Fisheries

Fishing is conducted in the rivers, canals, swamps, and lakes throughout the country, the apparatus used depending on the nature of the waters and the kinds of fish sought. Common implements of capture are bag nets ("pongpang"), various kinds of

seines and gill nets ("uan"), cast nets ("hae"), dip nets and scoop nets ("chon yai," "chon pai," "yok yaw," etc.), and wicker traps and baskets of many types, together with lines and spears. Where swamps and lakes discharge through narrow passages, various styles of barriers ("kabang," etc.) are set. During the annual upstream migration of the small cyprinid fish "pla soi," they are caught literally by millions in fine-mesh dip nets, used from the banks or from little platforms, practically every household along the streams having a net. "Pla soi" is used fresh or dried, and in some places where the fishery is concentrated and large quantities are available, an oil is extracted in open-air kettles or cauldrons.

The local markets are well supplied with fish, and where transportation facilities exist large shipments are made to Bangkok and other populous centres. Sometimes large rice-boats, filled with water, are loaded with live fish (serpent-heads, climbing-perch, feather-backs, cat-fishes, etc.) and poled or sailed to remote markets. There is an enormous consumption of fish in the families of peasants, and probably the chief importance of the fresh-water fisheries lies in providing a cheap, nutritious animal food for the millions of farmers and small merchants and their families.

Sea Fisheries

Fishing is done on all parts of the long sea-coast of Siam. The sea fisheries are engaged in by many thousands of people and yield a large volume of food, some consumed locally, some consigned to Bangkok and other large communities, and some exported to foreign countries.

An outstanding feature of the salt-water fisheries is the bamboo stake-trap ("poh") set in both shallow and deep water and consisting essentially of a circular enclosure made of bamboo poles driven into the bottom, a funnel-shaped opening into the enclosure, and long leader and wings for intercepting the fish and directing them into the trap. These traps are operated to the number of several thousand each year, and in favorite situations may be set in such numbers and such close proximity that they form a verit-

View of a slat trap on an interior stream.

Catch of a slat trap on an interior stream.

able maze. Some of these devices are set in water 18 metres deep and must be made very strong to withstand the action of the waves. The larger off-shore traps, requiring the most material and labour in their construction, cost from 5,000 to 10,000 ticals each. The success or failure of stake-trap fishing depends chiefly on the abundance of the little mackerel 'pla tu,' although many other kinds of fish enter the traps and contribute to the success of the fishery, and a few of them may, because of their numbers and market value, partly compensate for the absence or scarcity of "pla tu."

Another important form of apparatus used in the sea fisheries or at the mouths of streams is a kind of bag net ("pong-pang pak nam") set where, at the ebb-tide, there is a strong current. The water, richly laden with fish and shrimp, is strained through the loose brush sides of a long V-shaped funnel and the catch, concentrated at the point of the wings, passes into a fine-meshed bag suspended between two stakes. These nets, in large numbers, are set in various parts of the gulf, a very important fishing ground being off the mouth of the Menam Chao Phya.

Seines in great variety of size, mesh, and method of operation are used on all parts of the coast. Some seines are set from and hauled into boats, some are dragged on shore, some are used as barrages, being placed in positions on shores or flats that will be left bare at low tide and intercepting all creatures that have come to the shore at high water. These seines, sometimes stretching in unbroken lines for long distances, take a large toll. Lengths of bamboo matting placed end to end in the same manner as the barrage seines are also extensively used.

Trawl lines or set lines ("bet"), bearing numerous hooks attached at regular intervals are widely used for catching rays, sharks, and bottom fish generally. Some of these lines are baited, but frequently the hooks, with points filed to a needle-like tip, are left bare and act by fouling or snagging the fishes moving along the bottom.

An important fishing ground connected with the Gulf of

Siam is the so-called Inland Sea, or "Tale Sap," near Singora. Shrimps are the principal object sought, and the shrimp fishery there is the most extensive in Siam; bag nets ("pong pang"), large square dip nets operated by levers, and seines are used.

Certain kinds of nets extensively employed in the sea fisheries of Japan, America and western Europe, such as purse seines, floating traps, and otter and beam trawls, are unknown in Siam; but in the further development of the fisheries of the country each of these nets may be found to have a place. On the other hand, certain peculiar methods of fishing are in vogue in parts of the Gulf of Siam, such as the wearing of stilts by the fisherman in operating shrimp nets on soft muddy bottom and the use of flat boards instead of boats in gathering fish, crabs, octopods, etc., on mud banks at low tide.

Control of the Fisheries

The fisheries in both fresh and salt waters are under the control of the central government, and all operations are subject to the granting of a license and the payment of fixed annual fees. Exclusive privileges, such as the fishing in a given lake or the taking of turtle eggs on a given island, may be granted to an individual after competitive bidding. For fixed appliances, a fee is charged for the site as well as for the particular kind of apparatus. Certain preserved products entering into foreign trade are subject to an export tax.

The fisheries were for a long time administered as a function of the Department of Revenue, in the Ministry of Finance. In 1926 a royal decree established a Department of Fisheries in the Ministry of Lands and Agriculture, which will assume as rapidly as possible all the duties naturally pertaining to such a department.

CHAPTER X

AGRICULTURAL SCIENCE

The chief work of the Ministry of Lands and Agriculture is divided under the following heads:—Forest Department, Land Records Department, Department of Fisheries, Department of Mines and Geology, Department of Agriculture, and Cadastral Survey Department. Chapters on Forestry, Fisheries and Mining appear elsewhere in this volume.

Under the Department of Agriculture come the Division of Animal Husbandry and the Veterinary Division. The work of these divisions is explained in the companion volume "Siam: General and Medical Features." The other divisions of the Department of Agriculture include the Agricultural Experimental Stations and the Bureau of Agricultural Science, with the work of which this chapter is concerned.

The Bureau of Agricultural Science was founded in 1923 as an offshoot of the Department of Agriculture, and, up to May 1929, was dependent on the courtesy of the Ministry of Education for laboratory and office accommodation, since when it has been situated in a building in Rama V. Road.

The objects of the Bureau are those of an ordinary scientific

agricultural department and involve a close co-operation with the experimental seed farm at Klong Rang Sit and the experimental fruit farm at Bangkok Noi.

The task of putting the agriculture of the country on a scientific basis is an enormous one, and only a small beginning has been made.

The scientific side has at present three main divisions:—

(1) Agricultural Chemistry and Soil Technology.
(2) Economic Entomology and Plant Pathology.
(3) Field Experiments and Soil Survey.

(1) AGRICULTURAL CHEMISTRY AND SOIL TECHNOLOGY

The chemical laboratories are being fitted up, and when completed they will be adequate for the requirements of the next ten years. The latest type of petrol gas plant has been installed, together with modern electrical heating appliances, hot plates muffles, and ovens.

Rice

A full chemical and physical examination of the different varieties of padi, and the various qualities of rice turned out by the millers, with a view to the possibility of fixing on some standard for Siam Garden Rice No. 1 & 2, is being undertaken by the Bureau. (This was commenced at the Government Laboratory, where some fifty samples were analysed.)

Rice from the experimental plots is analysed periodically to find out how the nitrogen, potash, phosphorus, fat and carbohydrates vary in amount with different manurial treatment of the soil, and whether there is any relationship at all between quality and chemical composition.

Results already obtained show that the quantity of phosphates in the ash of the grain varies directly with the amount present in the soil; an interesting result in view of the supposed connection between phosphate content, vitamines and beri-beri. Incidentally it may be noted that dry grain crops, such as wheat, maize, and barley are practically unaffected by differences in the mineral content of the soil on which they grow.

Soils

A searching examination of the soil of the experimental plots is going on continuously. Each plot has been marked out into high-yielding and low-yielding areas, and the cause of this local variation is being investigated by a full chemical and physical analysis of soil samples from each area. This research has to be interrupted occasionally owing to the press of routine work.

Soil samples from various parts of the country are investigated with a view to ascertaining their suitability for special crops such as sugar and tobacco.

Soils from bad-yielding padi areas are analysed and compared with samples from good-yielding tracts, with a view to the amelioration of the former, if at all possible.

Other Investigations

A number of indigenous grasses and fodder crops have been analysed for their value in feeding cattle. Later on it is hoped to run feeding trials in conjunction with these analyses.

Irrigation waters and drainage waters are regularly investigated for the Irrigation Department.

Samples of minerals and salt lick deposits from officials up-country are received for analysis, if they are considered to be of any possible value in agriculture.

(2) ECONOMIC ENTOMOLOGY AND PLANT PATHOLOGY

The foundation of successful insect control is a general collection of all species, in order to know what are the probable pests and parasites. This is being done as far as a limited staff will allow.

The pests of padi and other plants of economic importance are investigated in the field and the laboratory, and remedial measures formulated. Very useful work in this direction has been done already. Show cases have been prepared illustrating different stages in the life histories of the more important pests.

These will be on view at the various provincial agricultural offices, while descriptive pamphlets will be distributed for the information and protection of the cultivator.

Considerable progress has been made in the discovery of the

food plants of indigenous insects and of the alternative food plants of those insects that normally feed on plants of economic importance. Batches of insects are sent regularly to England for identification by the Imperial Bureau of Entomology, and many species hitherto unknown to science have been discovered. The various pests of important crops, such as padi, coconuts, citrus fruits and mangoes, are being investigated thoroughly, and means of combating them are being worked out.

(3) FIELD EXPERIMENTS AND SOIL SURVEY

As far back as the year 1917 the Government saw the importance of pure seed, and started a seed farm at Klong Rang Sit for the purpose of improving the strain of padi by selection. Several good strains have now been produced and are being multiplied up for distribution amongst the cultivators. The work is being continued on slightly different lines to those originally adopted, taking as the starting point the best quality of padi as selected by the rice millers for any particular district.

Seed Selection

Three schemes have been adopted:—

(i) *Mass Selection.* The Lord-Lieutenants of all the Circles were asked to send in the best padi from each district to the Ministry of Agriculture.

These samples were examined and selected for quality according to the standard requirements of the rice-miller and the export market.

The names of the selected seeds were sent back to the districts from which they emanated, with instructions to the District Officers that they should endeavour to persuade the cultivator to use only those particular seeds for planting.

(ii) *Single Plant Selection.* Samples of all the best seeds selected as above were sent to the experimental farm, and planted out in small plots of 10 square wa (40 square metres). Single plants were selected for special characteristics, and the seed from one head was planted out in a row. In the following year a further selection was made for yield and quality and many strains

were discarded as unsuitable.

The selected seeds are divided into two classes :—

(1) Those suitable for high land.

(2) Those suitable for low land.

(iii) A special effort has been made to select seed suitable for the flooded areas, such as Nakon Nayok. This has been done by observation alone, and those plants of good quality and yield, that stand the deep water best, are kept for propagation, the selected seed being planted in the flooded plain at the junction of the two rivers.

Experiments with Fertilizers

At the Government Experimental Farm, Klong Rang Sit, fertilizing experiments were started in 1921 and some interesting results have been obtained. A new set of experiments was initiated in 1929 and, in addition, land has been allotted to various commercial firms on which they can demonstrate the value of their fertilizers.

The introduction of high yielding strains renders the use of fertilizers more necessary than before, as these will deplete the soil with greater rapidity than the cultivator's ordinary variety of padi ; but, on the other hand, an economic return from fertilizing is more readily obtainable when a high yielding strain is used, for it is easy to see that a 20% increase on a low yield may not pay, whereas a similar increase on a normally high yield will be profitable.

The padi soils are usually very acid, the Ph varying from 3.5 to 5.25. They are generally deficient in phosphate, but are well provided with nitrogen and potash. The clay content ranges from 30 to 50%. There is practically no under-drainage and the main crop of padi is grown under water from the time it is planted until the seed is set.

The experiments showed that :—

(1) All phosphatic fertilisers tried have given increased yields, and their effects have extended over three seasons.

(2) Ammonium sulphate gave a large increase in yield in

the first year, but further applications showed no advantage over the controls. The residual value was nil.

(3) Liming alone gave large and profitable increases up to a certain point, but liming to the stage of alkalinity resulted in decreased yields.

(4) Potash alone gave negative results.

(5) A "complete" fertilizer in the nursery produced stronger plants and a bigger yield in the field. Ammophos and Leunaphos gave similar good results.

(6) The yield of the untreated controls in the bunded areas at Klong Rang Sit has dropped steadily from year to year, in some cases to less than half in three years.

(7) Phosphatic fertilizing develops the root system very rapidly, and with broadcasted padi it is found that those areas so treated are much more resistant to periods of low rainfall and survive actual drought better than unmanured padi. With transplanted padi the plants are much bigger and stronger, proving more resistant to attack by diseases and insect pests. Crabs are found to destroy unmanured nurseries, but will leave alone the better developed, fertilized plants in the immediate neighbourhood.

The Treatment of Acid Swamp Soils

These soils, with a Ph value from 3.5 – 4.1, are found distributed throughout the canal area in Ayuthia and particularly Klong Rang Sit. Liming at the rate of 3–5 piculs per rai has been found very effective in increasing the yields, sometimes by as much as 75%. Continuous liming without the addition of plant food in the form of some kind of fertilizer is not an economic process, as it exhausts the soil too rapidly, but with soils of this nature the best results are not obtainable by the application of ordinary artificial fertilizers, as the soils already contain too much matter soluble in water.

It has been found that bat guano and bone meal give good results, and experiments are now being made with mineral phosphates ("Microphosphate" and Kossier Phosphate), with and without the addition of castor oil cake to supply deficiencies in nitrogen.

Lay-out of Experimental Blocks
Bangkok

Rice seedlings ready for Transplanting

Showing the effect of treating the seed-bed
with Leunaphos (20 % N. 20 % $P_2 O_5$)

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Buffalo Manure

In every nursery there can be seen groups of plants standing high above the other plants, of a much sturdier growth and darker in colour than the remainder. These groups are the sites of buffalo urinations or droppings, and show that the fresh excrement has a good manurial value, although the field experiments have always given negative results after the addition of buffalo manure. No doubt if the animals were fed more richly and the methods of storage were better, good results would be obtained by the use of their manure, but it would have to be applied in very large quantities. Probably it would prove to be an economic proposition only when used in the nursery.

Green Manuring

This is a well recognised method of maintaining and improving soil fertility, but on old padi lands leguminous crops cannot be grown with any reasonable prospect of success.

Isolated experiments at Klong Rang Sit under irrigation have been successful, but no method of general application has been evolved.

BANGKOK NOI FRUIT FARM

This was started in 1924 for the purpose of studying the varieties of local fruit trees. The objects of the farm are :—

(1) Improvement by selection.

(2) Improvement by budding and grafting.

(3) Comparing different methods of planting and cultivation.

(4) Use and effects of manures and artificial fertilizers.

(5) Methods of combating and controlling fungoid diseases and insect pests.

The results obtained already have justified the venture.

EFFECT OF IRRIGATION ON SOIL CONDITIONS

The investigation of the right use of irrigation water is an important task and one that has not been neglected in this country.

Where there are heavy soils with poor drainage and defective aeration, as in some districts in India, continuous irrigation is apt to lead eventually to the production of a soil condition known as "alkali". The soil becomes impregnated with sodium

salts and nothing will grow on it.

There is but little danger of trouble of this sort occurring in Siam, as the welfare of areas receiving irrigation water is always watched by frequent investigation of the soil water and the soil itself. Moreover the method of irrigation, being by inundation and not perennial, gives the soil a long rest during the dry season and it becomes reconditioned every year by the beneficial action of the sun.

In a normal fertile soil the clay is a complex compound of which the basic part is mainly calcium, and the acid part is an alumino-silicic acid. Under excessive irrigation the base calcium may be displaced by sodium, giving a sodium clay altogether different to the calcium clay, and having unattractive characteristics from the cultural point of view.

The Bureau of Agricultural Science is investigating this question of base exchange, and how far the fertility of padi soils depends on the nature and amount of these bases, particularly calcium, magnesium, potassium, and sodium.

Close attention is being paid to the water-extracts of padi soils and it is hoped to be able to classify them according to their salinity, and to define the limits for optimum growth. A considerable mass of data has been collected and interesting results are anticipated from their interpretation.

Water Requirements of Padi

For some years evidence has been accumulated that padi requires less water than is commonly supposed, and this year some exact experiments bearing on this point have been initiated in co-operation with the Royal Irrigation Department.

MECHANICAL FARMING

The plough commonly in use is a wooden one with an iron tipped share, which breaks easily and has poor wearing qualities. This plough is quite effective in the muddy padi fields under conditions where the heavy imported ploughs are quite useless. However an improved plough, known as the Krasetra plough, has been designed by the Department of Agriculture. It is made of steel and, although heavier than the native plough, it is quite as

handy and has the advantage of increased durability and a lighter draught. An experiment comparing the two ploughs showed that with the native plough one rai took 4½ hours to complete, whereas with the Krasetra plough the same area was covered in 2 hours and 50 minutes.

The Department of Agriculture have been experimenting with tractors for some years, but with varying degrees of success, depending on the time of year, class of soil, and depth of the ploughing.

There is no room here to publish a long list of trials, but as an example of what can be done we quote the following:—

(a) A crude oil tractor drawing a 5 share plough, turned over an area of 60 rai in 16 hours and 10 minutes, working on two separate days. The soil was a medium clay in the Ban Mee district, and was ploughed to a depth of 4 inches. The cost of the fuel worked out at 27 stangs per rai.

(b) A 24 HP tractor burning kerosene, working on raised clayey land, which is not so compact as the soil of a padi field, ploughed an area of 25 rai to a depth of 6-7 inches, followed by harrowing and cross harrowing, in 4 separate days of 10 hours each, at a fuel cost of 65 stangs. A three disc (18″) plough was used followed by a two share plough. The harrowing was done with a 24 blade 18″ disc harrow.

(c) A 10/20 HP tractor pulling a 12 disc plough on the light silty clay of Bang Pla Ma turned over an area of 50 rai to a depth of 4½ inches in 10 hours at a cost of 26 stangs per rai for fuel.

The ordinary cultivator really only scratches the soil to a depth of 3 inches, and the cumulative effect of this year after year is a tendency to produce a hard pan in the subsoil, which may or may not be continuous. Walking through a well prepared padi field, with the soil in good puddled condition for transplanting, one should sink down at least 12-14 inches at every step anywhere in the field, but frequently one comes to parts where the soft mud is only 4-6 inches in depth, due to the formation of this hard pan. Tractor ploughing to a depth of 7 inches rips up the hard pan, but at the same time it brings to the surface unoxidized subsoil, and

in consequence the first year's yield after this will be less than usual. Continue year after year giving the subsoil an opportunity of weathering and the yield will be higher than before, due to the improved physical condition of the soil, greater root development and consequent bigger feeding area of the plant.

Tractor ploughing and harrowing is most useful on large areas where the padi is broadcasted, as it allows the soil to be prepared much earlier than is possible by using animals. On transplanted areas the tractor can be used for the earlier stages of preparation, as long as the bunded plots are not too small to allow proper manipulation of the machine, but the services of the buffalo must be enlisted for the final stages of harrowing and puddling the clayey mud into the gruel-like state necessary for the satisfactory growth of the padi. Another advantage is the considerable saving of time that is effected. A trial at Lopburi with two similar areas gave the following results.

5 rai	ten buffaloes	10 men	6 hr.	18 min.
5 rai	crude oil tractor	1 man	2 hr.	5 min.

As a general rule a pair of bullocks will only plough the same area as one buffalo, but the ploughing may be a few inches deeper. It is estimated that one buffalo or a pair of bullocks is sufficient to keep 25-30 rai of land in cultivation, but this allows insufficient margin. A safer figure to take is 5 buffaloes or 10 bullocks per 100 rai.

In the Klong Rang Sit district a good young buffalo can be purchased for 45-50 Ticals.

There are a number of large farms in the country operating tractors successfully, but the high initial cost will always place the tractor out of reach of the individual cultivator; unless helped by some organization, such as a Co-operative Society.

Harvesting

Tractor driven harvesters have not yet proved themselves as successful as ploughs; chiefly owing to the uneveness of the fields and the tendency of the ripe padi crop to "stall." None of the machines tried have been able to pick up "stalled" padi, the stems of which are bent sharply downwards or lying on or near

Wind-mill operating paddle band-pump.

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the ground.

Threshing

Machines for threshing are in use on the Government Experimental Stations and other large farms and their employment could be taken up with advantage by the Co-operative Societies. All machines hitherto tried have the disadvantage of breaking the grain, from 3-6 % being the usual figures. The ordinary method of threshing by hand, or by the buffaloes treading out the grain, produces a negligible proportion of broken kernels, and where time is no object has much to commend it.

Pumping

In districts where water is available the padi farmer uses various contrivances for lifting it on to his land. The appliance in common use is called a 'rahat' and is really an Archimedes water-lift. This is worked by a windmill, by the hand, or by a kind of treadmill, and occasionally by little oil engines. Small suction pumps, working on petrol or kerosene, are becoming increasingly common among the more prosperous cultivators, and have often saved the crop for their far-sighted owners in times of drought.

Yield of Padi per Acre

The average yield of padi over the whole kingdom has usually been estimated at 4 – 5 piculs per rai (1340-1670 lbs. per acre), these estimates being based on the total crop harvested and the total area under cultivation. When yields are examined in detail there are found to be remarkable differences. The highest yields recorded without the use of fertilizer are :—

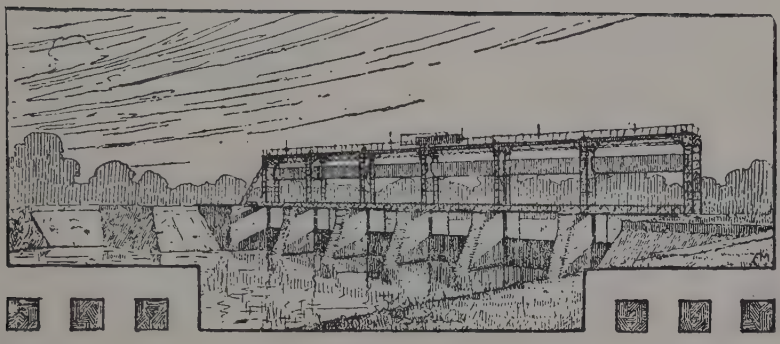
(a) 3562 lb. per acre in some fields near Bangkok, the variety sown being known as Kao Samue.

(b) 2900 lb. per acre in a district in the province of Nakon Chaisi, the variety sown being called Kao Lukon.

The lowest yields were from Klong 15, Prachin area, 435 lb. per acre and 675 lb. per acre, but these fields were suffering from insufficient water. The lowest yield, where a full supply of water was maintained by irrigation, was 705 lb. per acre on the Experimental Farm at Klong Rang Sit.

The yield of the same padi varies considerably in different districts and in some swampy areas adjacent fields show very big divergencies. These are due partly to variation in the depth of water, dissimilar aeration of the water, and the proportion of saline constituents of the soil. For example, the padi known as Nang Lerng gives 797 lb. per acre on one plot, and on a plot a few hundred metres away yields 1650 lb. per acre. Similarly the yield of Bin Keoh varies within a small area from 844 lb. to 1795 lb. per acre, and Nang Ta Nee from 726 to 1765 lb. per acre.

The life periods of the various classes of padi have been considered in another chapter, and vary from 75-210 days. As a general rule, other circumstances being equal, the longer lived variety gives the higher yield.



CHAPTER XI

IRRIGATION

Introductory and Historical Note

Siam within historical time has always been a rice producing country, rice has always formed the staple food of the people ; and, although the entry of Siam into the Markets of the world as a rice producing country dates back only 70 years or so, Siam rice has always borne a high reputation. Writers of the 17th. and 18th. centuries frequently refer to Siam's rice as being of a superior quality and much sought after by neighbouring countries, from which it may be gathered that even in those far off days, the seeds of Siam's present day development as a rice exporting country had already been sown. At the present time rice accounts for about 70 per cent. of the total export trade. It will be readily understood that with so much dependence on rice the question of water supply is of paramount importance, and with the question of water supply, the art and practice of Irrigation is intimately connected.

In Northern Siam, that is in the Lao Country, irrigation methods are thoroughly understood, as the cultivators are quite aware of the fact that without irrigation, it is impossible for them to secure a crop at all, and they display the utmost keeness in

carrying out works, with the object of forcing the rivers to contribute a portion of their supplies for the benefit of the thirsty lands coming within their spheres of influence. The works are primitive, as they must be, if they are to be within the means of the people to construct by their own unaided efforts, and the ubiquitous bamboo plays the principal part in their construction. The works are always liable to failure at the most critical period of the crop, but nevertheless the people have acquired considerable skill, based on experience through the ages, in carrying them out, and these works undoubtedly play a most important part in the economic life of the Northern Provinces.

In the Central Plains of Siam, which form the principal producing areas for Siam's Staple Commodity, conditions are different to those in the North. From the earliest times Siam here has depended firstly on rainfall, and secondly on the rise of the rivers to such a level that they will spill over their banks, and inundate the crop producing lands on either side. Rainfall over the whole of the Central Plain, except in certain well defined and comparatively small areas, supplies directly only about half the quantity of water required to mature a rice crop under the conditions of cultivation as practised here. In this Siam compares very unfavourably with her principal competitor in the rice trade, Burma, where the main rice producing areas receive an average rainfall more than double that which Siam's areas receive. This is easily explainable by the high range of hills which form the boundary between the two countries. These intercept the south-west monsoon currents and cause heavy precipitation on the Burma side, leaving a monsoon much weaker in moisture to supply the needs of Siam. In order to make up for the deficiency of direct rainfall, therefore, dependence is placed on the rise of the rivers to inundate the growing crops, and this is so well known that it hardly needs amplification. What however may not be generally realised is that this very dependence on the rise of the rivers, so that they will inundate, or in other words irrigate the rice fields, means neither more nor less than that Siam depends, and has always depended, on irrigation to bring

her crop to maturity. The natural rise of the rivers to inundation level has from time immemorial constituted the principal economic event of the Siamese year, its coming is eagerly looked for in all quarters.

It may be of some interest here to analyse briefly the natural resources of water supply over the Great Central Plain of Siam. These are :—

a) The rainfall.

b) A rise of the rivers to inundation level so that the lands will be supplied with water necessary to mature the crops.

a) RAINFALL.

The area comprising the principal rice growing districts, known as the Great Central Plain, is that extending from Nakorn Sawan in the north to the Gulf of Siam in the south, to the watershed between the Menam Chao Phya and the Menam Meklong on the west, and to the watershed between the Menam Prasak and the Menam Mekhōng on the east. In the chapter dealing with climate in this volume, it has been shown that the average rainfall during the rice growing season over the Central Plain is 1,052 mm. (41.43″). Now it is well known, from records kept in tropical countries dependent on Irrigation Works, and where the water supplied has been carefully measured, that a total depth of water for rice, spread over the growing season, to mature a hundred per cent. crop, is 6 feet or 1,800 mm., including absorption and evaporation losses. Therefore, in an area which has rainfall of only 1,052 mm., it may be stated definitely that of itself the rainfall is generally deficient.

In this connection, however, it may be noted that in Saraburi, which forms the North Eastern Area of the Central Plain, the average rainfall is from 1,500 to 2,000 mm., which is fortunate as, except in times of abnormal flood, this district does not receive the benefit of river inundation. Saraburi consequently depends almost entirely on rainfall for its rice production, and due to its position under the south-western slopes of the Korat hills, the rainfall may be stated as being generally just sufficient for its needs. This fact was confirmed during a recent tour up the

Prasak River, when it was observed that in the district receiving an average rainfall of more than 1,500 mm. the crops were good, while further north they became very scanty indeed, until a point was reached beyond which there were no crops at all. This illustrates the necessity of supplementing rainfall supplies by other means where the quantity of rain falls below a certain limit.

In examining rainfall statistics, due notice must be taken of the variations of intensity and distribution, not only over the country as a whole, but over comparatively limited areas. Countries which depend for their agricultural welfare entirely on rainfall uncontrolled, know to their cost what a large part these factors play in the well-being or otherwise of their crops. A year seldom occurs in which the rainfall spread over a crop is so perfectly distributed, as to be entirely suitable for each agricultural operation necessary to bring that crop to maturity:— e.g. at the time of sowing there is often rainfall of such intensity as to be prejudicial to the crop at the outset. Again, when the plants are coming into ear and urgently demand water, there occurs very often a serious break in the continuity of the rains, and even though the crops are able to survive until the end of the break, the resulting outturn suffers, and the crop is not nearly so good as it would have been, had a supply of water been available at the right time. Further, in examining records of a particular district, it will be found that rainfall varies considerably in intensity over short distances, some parts receiving excessive rainfall and other parts little or nothing. Siam is fortunate, in that famines, such as have swept India from the dawn of history, have been few and far between, and those that have occurred have been due rather to disturbed conditions brought about by successive wars rather than by climatic conditions. In the past in India, that famine would follow a failure of the rains was as sure and certain as that night would follow day, and it is only the great Irrigation Works which have been brought into being within comparatively recent years that now keep that gaunt spectre at bay.

Rainfall failure, partial or complete, in Siam has, however, a very uncomfortable effect on her economic condition, and two or

three years of failure in succession would probably bring her very nearly to the famine stage.

b) RISE OF RIVERS TO INUNDATION LEVEL.

If it be recognized that in the Central Plain the rainfall of itself is insufficient to mature the rice crops, a supplementary supply must be looked for, and in deltaic tracts Nature provides for this by means of the rise of the streams at certain times to such a height, that the rice lands on the banks become inundated. This fact, as regards the Central Plain, is so well recognized that it requires no further emphasis; it only remains to state the conditions which are necessary to the production of a satisfactory crop. These are:—

a) Satisfactory rainfall at the beginning of the season for preliminary operations.

b) Sufficient rainfall to bring the crop to such a state of maturity that it can stand inundation.

c) Inundation by the rivers to mature the crop, but not high enough to swamp it, and to last the length of time necessary to bring the crop to full bearing.

d) That the rivers should fall from inundation level in time to enable harvesting operations to be carried out.

When all these conditions are fulfilled, a full crop may be expected, but when they vary in any degree, or are not fulfilled at the right time, the crop suffers directly as the conditions prevailing depart from the ideal.

It is necessary, therefore, to study available records over a long period, to ascertain what proportion of good years may be expected, and whether these good years constitute a large percentage of the whole, and the bad years are few and far between; and further, whether the average years are so few that any improvement, which could be effected by the construction of irrigation works for the purpose of converting average years into good years, would be negligible. If such were the case here, then it might be stated at once that Siam had no need of any expensive irrigation works, so far as the main rice-producing tracts were concerned. If on the other hand, the reverse were the case, it would appear that expen-

diture spent on irrigation works can be contemplated with equanimity, with the sure and certain knowledge that such works add immensely to the national wealth of the country, and the money sunk would be returned to the State indirectly, if not directly.

In this respect, through the kindness of the Authorities in charge of the National Library, the Irrigation Department is in possession of a most valuable record of the annual rise of the Menam Chao Phya and of its tributary, the Menam Prasak, at Ayuthia. This record has been secured from a scale model of an original gauge maintained at Ayuthia, on which the highest water levels of the rivers for the year have been recorded over a period of 99 years. This model is kept in the National Library at Bangkok. The Irrigation Department have referred these records back as nearly as possible to mean sea level datum, and the results indicate the inundation level of the rivers. If this level is not reached, it simply means that the crops over a large area will be subjected to very heavy damage, if not to almost total failure, as was the case in B. E. 2462 (1919), when the value of the rice exports fell from 124,000,000 to 28,000,000 Ticals.

The records of this gauge show that out of a period of 99 years, in 6 years abnormal high water was recorded, and in 9 years, water supply was excessive. In both these periods, there must have been considerable loss on account of floods and the necessity for flood protective works must have been acutely felt. In 32 years, the records indicate that water supply conditions were distinctly good, and so far as existing areas of cultivation were concerned, there would have been little need for irrigation works; but for extension of cultivation into the waste lands not so favourably placed as regards water, and consequently not brought under the plough, even in these years, the necessity for irrigation works would have been apparent. In 22 years the supply, could be classed as average and considerable improvements could have been effected by means of irrigation works. In 30 years recorded river levels were distinctly poor and heavy damage to crops must have occurred on account of lack of water, and in these years, the

necessity for extensive irrigation works over the whole country was beyond dispute. It cannot be too strongly emphasised that in most of these years river supplies were ample for all needs, but they were at too low a level to inundate without assistance.

Under the constantly varying conditions of water supply, as briefly touched upon in the above paragraphs, it is not to be wondered at that the country as a whole has gradually developed an irrigation sense and its growth can be traced through history.

In the Sawankalōk and Sukhothai Provinces, from where modern Siam first evolved, traces exist of works probably having for their object the supply of water to the country on which the ancient capitals depended for their food supply.

In the Ayuthia Period works for similar purposes were constructed by the Government of the time, or by private individuals anxious to assist in the development of their country Well known canals constructed in this period are in use at the present day.

Under the beneficent rule of the present reigning house in Siam, the Maha Chakri Dynasty, of which H.M. King Prajadhipok is the 7th of the line, numerous canals have been dug for supplying water to the growing crops; it, however, remained for His Majesty's august father King Chulalongkorn to inaugurate the policy of the construction of modern irrigation works, so that all Siam's natural resources can be used for the well being and prosperity of her people to the fullest extent. The policy so inaugurated has been carried on steadily by His Majesty's late brother, King Rama VI., and by Himself.

Rangsit Irrigation Scheme

This was the first attempt in the Central Plain of Siam to construct an Irrigation Scheme on modern lines Visitors to Siam who are proceeding by rail to view the Ayuthia or Lopburi Ruins, will notice on the right hand side of the line, after leaving the Aerodrome Station, Don Muang, an immense flat almost treeless plain. In the dry season this has a burnt up appearance, but in the rice growing season the whole plain is one vivid green colour as far as the eye can reach. The plain extends almost up to the

Station of Bang Pa-In, where His Majesty's river palace is situated. This plain comprises what has been and is still known as the Rangsit Concession Area. This area, some 50 years ago, was covered with elephant grass and a series of swamps. It was in fact the home of wild elephant herds, and was a famous gathering ground for wild elephants when they used to be driven to the old stockade or kraal which is still in existence in Ayuthia.

About 45 years ago a company, known as the Siam Canals Land and Irrigation Company, obtained a concession from H. M. King Chulalongkorn to dig a series of canals in this area, and to construct locks and irrigation sluices The works, however, were merely retentive works, and could do nothing to increase supplies in times when the rivers were too low to inundate of themselves. At the same time the country owes a debt of gratitude to the pioneers who thought out and constructed these canals; they undoubtedly added very considerably to the rice producing areas of the Kingdom. The scheme marked a great advance over anything that had been done before, and it has been mainly responsible for all that has been carried out since in the way of irrigation works. It was hoped that irrigation schemes carried out on the lines of the Rangsit Scheme would be sufficient to provide or maintain the exportable surplus of rice for export, on which nearly the whole of the economic prosperity of the country depends; and that gradually such schemes would cover the whole of the Central Plain. Fundamental defects, however, soon made themselves felt, and that works more comprehensive in character would be necessary, if Siam was to maintain the position she had won for herself in the world's Rice Markets, was evident.

In the year 2442 B. E. (1899) the then Minister of Agriculture, the late Chao Phya Devesr, after an extensive tour through the Rangsit Area, obtained the sanction of H. M. King Chulalongkorn to obtain the services of Mr. Homan van der Heide, an eminent hydraulic engineer from the Netherlands East Indies. Mr. Homan van der Heide remained several years in the service of the Siamese Government, and while questions of finance prevented the realization of main

Chulalongkorn Lock.

Constructed in 1896.

Chulalongkorn Lock.

Rebuilt in 1929.

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irrigations works which he projected, he brought into being a fine system of navigation canals, locks, and sluices for the conservation of water in the Southern portion of the Central Plain. These works have now become integral parts of later schemes which have been carried out.

Mr. Homan van der Heide left Siam in 2452 (1909) to take a leading position in the irrigation service of his own Government. From this date the Government decided not to proceed further with irrigation works, but climatic conditions did not allow matters to rest, and a few years later a commission, under the guidance of His Royal Highness the late Prince Rabi, reported that to concentrate on irrigation works for improving rice production was the best means to avoid frequent set-backs on account of capricious water supply, when entire dependence had to be placed on unassisted natural resources. In arriving at their conclusions, the Commission dealt largely with the Rangsit Area. Following on the recommendations of this Commission, the services of Mr., now Sir Thomas Ward, one of the foremost living irrigation experts, were obtained through the Government of India.

Sir Thomas Ward drew up comprehensive schemes covering, not only the whole of the Central Plain, but for the Northern Provinces as well, where, although the art of irrigation, as already noted, had been practised for centuries, much could be done in saving water, not only for use in the actual areas of farm lands in the North, but for the areas lower down in the Central Plain. This could be achieved by the construction of modern works, capable of withstanding heavy floods, in place of the somewhat flimsy bamboo constructions, and by amalgamating countless irrigation channels of all sizes and shapes into a few constructed on approved hydraulic principles. Before Sir Thomas Ward left Siam, His Majesty King Rama VI. ordered the re-inauguration of the Royal Irrigation Department on the form in which it exists at the present time.

The object of irrigation as now understood in Siam is to ensure

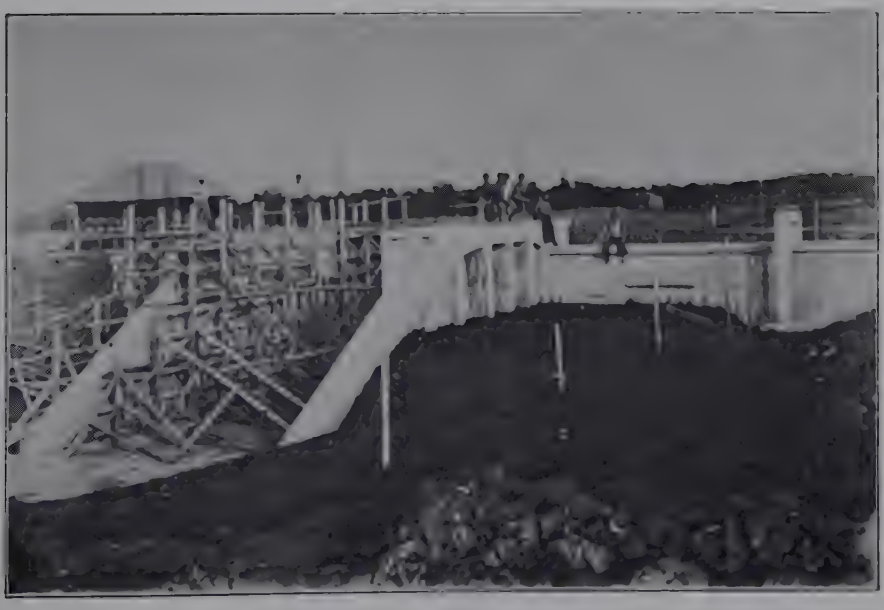
that all available water supplies can be given to the growing crops at all stages of the rivers whenever required and, by assuring a dependable supply, to stabilize production. His Royal Highness the late Prince Rabi, in his minute on Sir Thomas Ward's report, states that the object the Government had in view in introducing Irrigation Works was "to enable the farmers of Siam to maintain against the increasing competition of neighbouring rice-growing states fostered by energetic governments, the position hitherto held by Siam in the rice markets of the world." This statement constitutes Irrigation's Charter in Siam, where climatic conditions are such that irrigation works can never yield the handsome direct profits to the State that similar works yield in dry countries which depend entirely on irrigation, and which are so placed that they have unlimited areas of waste land to bring under cultivation, a natural attribute of scanty rainfall, and have densely over-populated districts to draw upon for the necessary man-power to cultivate new areas. With works constructed under such conditions, Siam's Irrigation Works can never hope to compare as regards direct profits to the State, but they can and will achieve similar results in adding to the national wealth and prosperity of the Nation.

Prasak South Canal (*Klong Rabibadhana*)

This was the first of the schemes projected by Sir Thomas Ward to be taken in hand. The work was commenced in B. E. 2459 (1916) and, as far as Government channels were concerned, was completed in B. E. 2465 (1922). The capital account for the whole scheme now stands at Tcs. 15,780,768. The main object of the scheme was the improvement of conditions in the important Rangsit Area, which, as will be understood from what has already been written, had passed through many vicissitudes since the project was carried out by the Siam Canals Land and Irrigation Company. The concession to the original Company lapsed just at the time Sir Thomas Ward's different schemes for the Irrigation of the Central Plain were being considered, and this led to a decision to inaugurate the present day system of Irrigation Works with the Prasak Canal Scheme.

Type Royal Irrigation Department Regulator

Ayuthia Plain.



Type Regulating Sluice

Reclamation work on sea-coast.

The principal work in the system is the regulator or barrage on the Prasak River, and as the river runs generally between high banks, except at its confluence with the main river at Ayuthia, the works which are necessary to raise the required level are of considerable magnitude.

The site selected for the Barrage is situated in the district of Tharua in the province of Ayuthia, and is about 4 Km. due west of Tharua Station on the Northern Line to Chiengmai. The works can be conveniently visited from this station. The two main reasons governing the selection of this site were:—

(a) That it is at the highest point of the river from which the works could be fed from a barrage constructed on the Menam Chao Phya, and without which the irrigation system of the Central Plain can never be complete.

(b) The site offered special facilities for construction, as the river here makes a long hair pin bend, and almost doubles back on itself, the works therefore were placed in the chord of the bend, and the river was diverted over the works when completed at comparatively little expense.

The stone used is a hard crystalline limestone well suited for works of this nature; it was quarried about 30 Km. upstream from the works. The type of construction adopted is rubble masonry throughout, with special precautions for securing proper bond in the piers and retaining walls by the interpolation of reinforced concrete slabs. The foundations consist of a solid concrete slab reinforced with old steel rails and pinned well down into the clay by extensions under the piers. The slab is faced on its upper surface with ashlar blocks quarried and cut, with considerable difficulty, at the same quarry from which the rest of the stone was obtained.

The Barrage has 6 openings, 12.5 metres in width and 12.1 metres in height. Into these openings are fitted single regulating gates, each gate being 13.1 metres in length and 7.5 metres in height. The gates are worked on the "Stoney" system with free

rollers, and are fully counterbalanced. Each gate weighs 41 tons. The gates are operated by manual labour from a platform carried on a steel superstructure, and about 11 metres above the top of the masonry.

In addition to the Barrage the following works were also constructed :— A Head Regulator to regulate the water entering the main canal. In general design and construction it is the same as the barrage, of which it forms a part. It has 8 spans which are also closed by steel gates worked on the "Stoney" principle.

A river lock to pass boats between the two levels of water maintained by the Barrage, which in the dry season may be as much as 7½ metres, and special features of this lock are the lower gates which are 9 metres in height.

Another smaller lock was necessary to provide for traffic between the river and canal and vice versa.

The total cost of the Headworks, including buildings roads, and bridges amounted to about Ticals 4,150,000, and in the construction the following materials were used :—

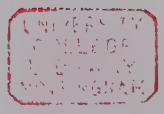
Rubble Stone	...	42,500	Cubic metres
Stone Aggregate	...	19,000	„
Sand	...	18,000	„
Cement	...	7,250	Tons
Steel in foundations	...	170	„
Steel in gates etc., of the various works	...	716	„

The Irrigation System

This consists of a main canal, taking out of the Prasak River above the barrage. The canal runs in a southeasterly direction for a distance of 32 Km. to a point in the District of Nong Gé, where it bifurcates into two branches, a western and a southern branch, both these branches serve the Rangsit Area, and for the greater part of their lengths original canals dug by the Siam Canals Land and Irrigation Company have been utilized.

Phra Naret Lock.

Phra Narai Lock.



The Western Branch is about 37 kilometres in length, and the Southern Branch is about 28 kilometres in length. The main canal has a bed width of 40 metres at the head, reducing to 29 metres at the bifurcation. The depth is 3 metres throughout, and the channel is designed to carry a discharge of 100 cubic metres per second at its offtake.

In carrying out the irrigation system due provision was made for navigation, and although this adds enormously to the cost of irrigation canals, the increased expenditure was very necessary, as in the districts served by them roads are practically non-existent.

In the alignment of the main canal several large natural drainages, which come down from the western slopes of the Korat hills, and have direct connection with the Menam Chao Phya, had to be crossed. These drainages presented considerable engineering difficulties, and were dealt with either by absorbing them into the main canal or by passing them under the canal by large syphons.

The canals were constructed almost entirely by machinery, as the ordinary methods employed in the country of excavating by hand labour, the labour for this class of work being exclusively Chinese, would have proved prohibitive in point of cost. It is believed that Siam was the first country in the East to introduce large drag line excavators which originated in the United States of America, and had proved so successful as earth movers.

Distributing System

This is done by means of distributaries or laterals, and by direct outlets taking out from the main canal and branches. The total length of these channels is about 360 kilometres. They were constructed entirely by manual labour. All the channels have been carefully aligned on the ridges of the country, so that general flow is from the supply canal to the drainages. Details of the areas commanded and proposed to be irrigated annually, are given in the statement below. Natural drainage lines have been selected as the boundaries of the areas commanded by each distributary, and these drainage lines are generally never crossed.

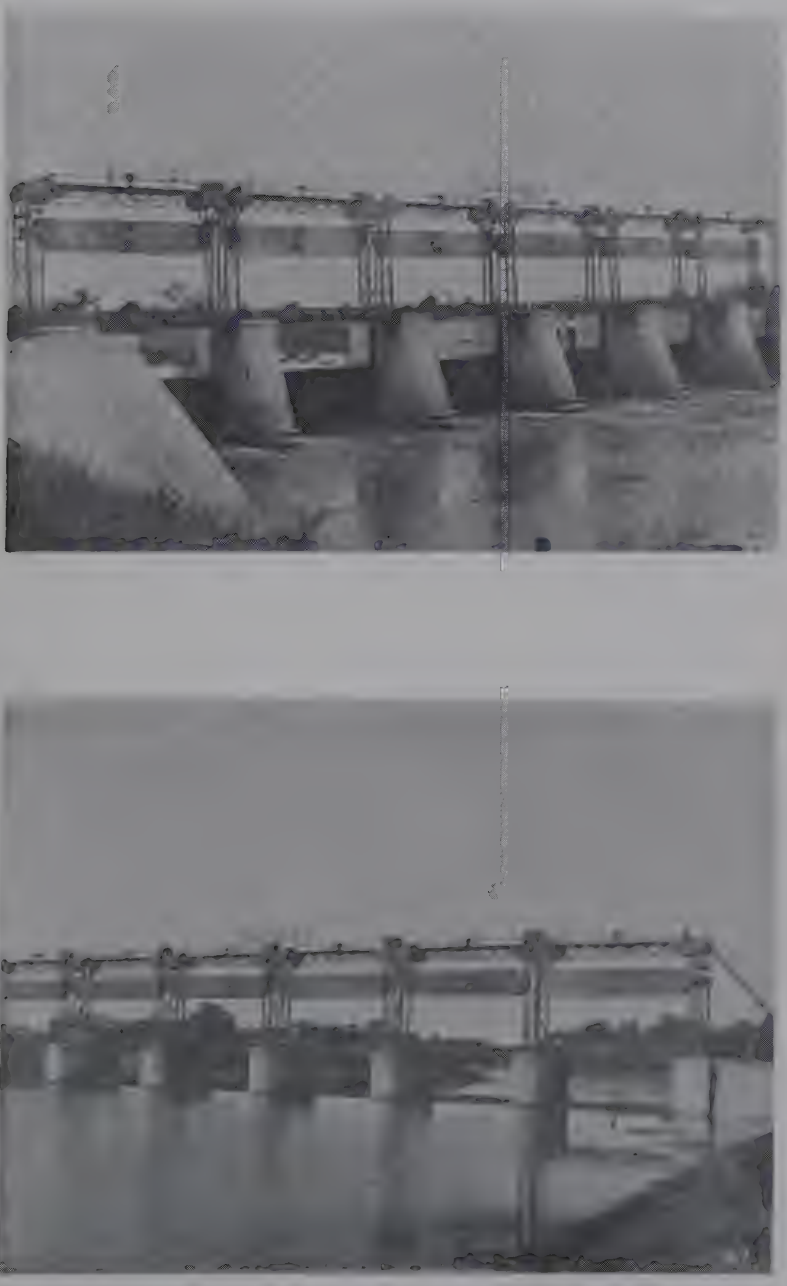
STATEMENT OF COMMANDED AND ANNUAL IRRIGABLE AREAS IN DIRECT IRRIGATION SYSTEM AND ACTUAL AREAS IRRIGATED.

Channel	Gross Area commanded.	Irrigable Area 75% of Commanded Area	Actual Area irrigated annually 2466 to 2470 (1923-27) 5 years
	Rai	Rai	Rai
Main Canal	192,654	144,488	150,729
Western Branch	311,154	233,367	225,450
Southern Branch	190,190	142,409	34,201
Total	693,998	520,264	410,380
Indirect Irrigation Area	317,446	238,107	168,165

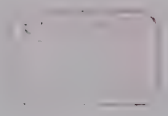
While the works were completed in the year B. E. 2465 (1922) and commenced to operate in that year, they were not officially opened until November 29th. 2467 B. E. (1924). His late Majesty King Rama VI. was pleased on this date to declare the works open for the benefit of his subjects. His Majesty was pleased to order that names to indicate the principal works should be given to commemorate famous Kings of the Ayuthia Period, in recognition of the fact that the whole of these works are situated in the Ayuthia Province. The only exceptions to this were made in the case of the main Barrage on which the works depend, regarding which His late Majesty graciously granted the request of the Minister of Agriculture that it should be known for all time as King Rama VI Barrage, and in the case of the main canal and branches on which the name Rabibadhana was conferred in memory of H. R. H. the late Prince Rabi, who was responsible for the policy bringing them into being.

Jiengrak and Bang Hia Drainage Project

This Project, which is complementary to the Prasak Irriga-



Rama VI Barrage.



tion Project, was commenced as the latter approached completion ; it, and the construction of the third regulator portion of the Suphan River Project, were the only two additional Projects on which the Royal Committee, appointed by His late Majesty King Rama VI. in 2466 B. E., recommended that work should at that time be continued. His late Majesty was pleased to accord sanction to the recommendations of the Royal Committee, and strictly in accordance with the amounts sanctioned for yearly expenditure from that time onwards, progress has been made with the construction of the works included in the Jiengrak and Bang Hia Drainage Project.

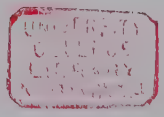
The northern part of the scheme aims at the conservation of water supply in that portion of the Ayuthia Plain which lies on the east bank of the Menam Chao Phya, and extends from Ayuthia in the north, to Klong Rangsit in the south. The area is distinctly an inundation area, and receives its main supply from Klong Ban Ma north of Ayuthia. When rainfall is plentiful and the main River at Ayuthia rises to proper inundation level, this portion of the plain receives adequate water supplies, but on the other hand, when the river fails to reach the required level, whatever water which may find its way into the area flows out again rapidly through a series of large drainage channels which rejoin the river south of Ayuthia, without inundating the crops sufficiently to bring them to maturity. Now if during years of low supplies, it is possible to retain the water on the rice fields, until such time as the rice is matured, and afterwards to provide for efficient drainage, the benefit to the area will be incalculable. The object in view can be achieved by the construction of suitable regulators and embankments, and these have now been completed. Under this scheme also Klong Prem, which was dug in the 5th reign to provide a ready means of access from Bangkok to Ayuthia, but which has been allowed to silt up and practically go out of use, will be opened up again, and will be provided with a suitable embankment along its western side. By means of this embankment it will be possible to maintain the water level at such a height that the large area lying between Klong

Prem and the river can be irrigated through outlets in the bank. Any one travelling along the Northern Railway during the crop season in almost any year, cannot fail to be struck with the necessity for ensuring the supply of water to this area.

By means of the works constructed in connection with this Project, water flowing from the hills in the east, along natural drainage lines, which in their course pass under or across the Prasak South Canal, will also be diverted over the rice growing tracts as may be necessary, or if not required allowed to follow its natural route to the Menam Chao Phya. It will also be possible to utilize supplies from the Prasak South Canal for the same purpose when such can be spared.

In the southern portion of the scheme, the problem to be solved was three fold:—(1) to provide efficient drainage for the whole area including the Prasak Area, (2) to be able to conserve water when required to meet the needs of the crop, and (3) to supply sufficient fresh water to render fit for cultivation salt ridden tracts along the sea coast, and to rigidly exclude sea water. The works necessary include main drainage canals on the east, west, and south, the last is combined with a levee or sea dyke 60 kilometres in length. The canals link up all the navigation canals, already referred to as having been designed by Mr. van der Heide, and allow of full use being made of all sluices and locks built in connection with them, including the Bang Hia Sluice, from which the system takes its name. In addition the drainage sluices have been added to enormously, and the area is now amply provided in this respect. In order that every available source for fresh water supply may be made available, a scheme has been prepared for the utilisation of the Nakorn Nayok River; this has now received Government sanction, and work has been started. The Jiengrak and Bang Hia Scheme will be completed at the end of the present year, and the total cost will be approximately 7,778,000 Ticals. The Nakorn Nayok Scheme is estimated to cost Tcs. 5,948,186, and when this is completed, the total capital expenditure to provide for the area extending from the Prasak River to the sea will amount to about Ticals 29,000,000, and this expenditure will have

Ekatosarat Bridge.



been spread over a period of 17 years. The total area protected, and provided with facilities for irrigation, navigation, and drainage is 3,385,320 rai, which is equal to about 540,000 hectares or 1,333,000 acres.

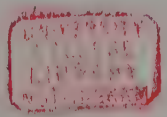
Suphan Project

This project was most strongly recommended by Sir Thomas Ward, as the one which should have priority of all the schemes designed by him. Proposals for this scheme were made as soon as the Prasak Scheme was completed, but financial exigencies made it essential that the works should proceed very slowly.

The scheme has therefore been divided into sections, and each section forms a small self-contained project. The first section to be taken in hand was the third or lowest section, which is almost completed, and has been in operation the last two or three years, and Government has recently sanctioned work being started on the uppermost section.

In connection with the Suphan Scheme it may be noted that it depends essentially on the canalization of the Suphan River. This river is a branch of the main river which it leaves, some 200 kilometres north of Bangkok, and has a separate outlet to the sea. It follows a course midway between the Menam Chao Phya and the Meklong River. At one time, like all deltaic rivers, the River Chao Phya must have had many separate outlets or mouths, but these have silted up, and the Suphan River, the last of them, has been rapidly silting up at its head, making the works which are now being undertaken very necessary; as the river serves a large tract of country on the west side of the Chao Phya River. The head reach is now being silt cleared, and a head regulator is being constructed for the purpose of controlling the supplies in the remodelled channel, and these will be utilized to irrigate the lands, to a large extent virgin jungle, lying on each bank. The total length of channel to be canalized is 123 kilometres, and from this remodelled channel distributaries will be taken out. The necessary levels will be maintained by a series of regulators or barrages in the parent channel.

The estimated cost for all works which have been sanctioned



by Government to the present year B. E. 2473 (1930) amounts to Ticals 7,949,340, and this expenditure will be spread over a period of 7 years.

Irrigation in the Northern Provinces

A sum of Tcs. 2,000,000 has now been sanctioned for Irrigation Works in the Provinces of Chiengmai and Lampang. Conditions here are entirely different from those in the Central Plain. In the latter it cannot be said that Irrigation Works are essential to the production of a crop, though they are essential, if apart from supplying the needs of the people themselves, there shall be a steady surplus available for export; in the former, however, with a considerably less rainfall, and an entirely different configuration of the valleys, irrigation by artificial means is essential to the production of a crop at all, and this, being well recognised by the people themselves, makes the work of drawing up a project with a view to obtaining a direct return on the capital expended a simpler proposition. One very important condition regarding irrigation is fulfilled in the North, which gives it a distinct advantage over the Central Plain, and that is the existence of skilled irrigators. In the North all cultivators are skilled irrigators, in the Central Plain there are skilled farmers by thousands, but skilled irrigators are few and far between. Another feature is that in the North the farmers are accustomed to, and willing to pay irrigation rates, while in the Central Plain the cultivators never have paid for water, and they consider that it should be as free as sunlight and air. Such considerations as these offer a tempting prospect for the success of works in the North, though the Northern plains can never compare with those in Central Siam as rice producers.

In the Chiengmai Valley a very considerable portion is irrigated already, but the methods employed are primitive, and there is great scope for improvement. A start is now being made on Government works, the necessary machinery has been procured and the works should be in full swing in the dry season of the present year.

In the Lampang Plain the River Me Wang has proved too

Royal Irrigation Department Dredger No. 10.

Klong Ban Mai Dam, Meklong River.

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much for local effort, and works on the scale of those which are a feature of the Chiengmai Valley do not exist. The valley has never been able to grow sufficient rice, even to provide for home consumption, and invariably has to depend upon importation from other districts, especially from Chiengrai.

With the advent of the railway, if the Me Wang Valley is made self supporting, which can be achieved by bringing the river under control, more rice will be available from the North to augment the country's exportable surplus.

Surveys for an irrigation scheme have been completed, and as soon as work in the Chiengmai Plain is well under way, irrigation of the Me Wang Valley will be taken seriously in hand.

Irrigation by Mechanical Means

In recent years the Irrigation Department has paid increasing attention to the provision of means for helping the cultivator over dry spells by lifting water by pumps on to the rice fields. For this purpose a fleet of large capacity floating pumping units have been built.

CHAPTER XII

THE RICE INDUSTRY

With a view to catching the fancy of their readers, foreign writers on Siam have given this country various romantic names, such as 'Lotus Land', 'An Asian Arcady', 'The Land of the White Elephant', 'The Land of the Free', and a long list of others. 'Land of Rice' is a name that would sound equally romantic and be more appropriate; for though other countries produce rice, few can touch that of Siam in quantity and quality.

The following article is an attempt to show how important a part rice has played in the life and progress of this vast, but little known country.

The Importance of Rice

To appreciate the importance of rice to Siam, one need bear in mind only two facts: first, that rice is Siam's principal product and her people's staple food, and secondly, that it accounts for nearly 70% of her export trade.

Rice not only enters into human consumption, but also forms the much-coveted food of domestic animals as well. Elephants, horses, cattle, pigs, dogs, cats and fowls eat it, and so do the fish in the ponds. Rice figures prominently in all religious ceremonies and social gatherings. It enters the human mouth in various

forms, both as food and drink. As a daily food, it is cooked and taken together with other side-dishes; it is also made into cakes, sweetmeats and puddings. As a drink, it is distilled into the famous "lao rōng", or arrack liquor, which is drunk all over the country. The manufacture of "lao rōng" is a Government monopoly.

Rice is indispensable to a Siamese as long as he lives. He learns to eat it while still in his cradle and continues to do so till he dies. There are many kinds of food and fruits that a Siamese doctor of the old school would proscribe as unwholesome for his patient, but he would never forbid the taking of rice. Were he to do so, he would surprise not only his patient but also himself. The patient, too, would consider himself doomed if he could not take his rice.

Rice is so intimately bound up with the life of the Siamese people that the word "rice" has become part and parcel of many common phrases. For instance, where the European says "goods and chattels," the Siamese says "rice and chattels." For famine, the Siamese says, "rice is difficult (scarce) and betel-nut is dear." Among the peasant class one often hears in the morning and evening people greeting one another with, "Have you eaten your rice?," which to them conveys the same idea as "Good Morning" and "Good Evening."

The purchasing power of the great mass of the people depends, to a very large degree, on the rice crop, and imports as well as the internal trade of the country depend on that purchasing power.

Cultivation of Rice

Physical and climatic conditions in Siam are specially suitable for rice cultivation, and as rice is both the staple food of the Siamese and their principal export, they plant it first and foremost and on an ever-increasing scale. The Siamese have been planting rice from time immemorial.

The Kingdom of Siam is divided for administrative purposes into fourteen Circles, and rice is grown extensively in every one of these; but the chief seat of the industry lies in the seven Inner Circles, viz., Krung Tep (Bangkok), Ayudhya, Nakon Chaisi,

Rajaburi, Nakon Sawan, Prachin and Pitsanulok, which form the great Central Plain of Siam, watered by the Menam Chao Phya, the main artery of Siam, and its daughter rivers and tributaries. It is this Central Plain that supplies most of the rice for export, and thus brings to the country a large measure of prosperity and progress, although more and more rice is now being brought down by rail from the northern and north-eastern provinces.

Of the seven Circles above-named, and indeed of the whole Kingdom, Ayudhya is by far the greatest rice-producing centre. In fact, the Ayudhya crop may be largely taken as an index to the prospects of the rice trade in the season following the harvesting..

Ploughing Ceremony. Rice being the life-blood of the country, it would be a matter of wonder if its cultivation were not inaugurated with a ceremony. This is known as the Raek Nā (Raek = first, Nā = field) or first ploughing, for a description of which the writer asks to be allowed to quote a passage from a book called "Siam and its Productions, Arts and Manufactures," compiled by Colonel G. E. Gerini, which says: "For centuries, in Siam, a high dignitary of the State, appointed by the sovereign, has always presided at the ceremony with great pomp and solemnity. Nowadays it is presided over by the Minister of Agriculture. The plough, the bullocks, and the seed are blessed by the Buddhist Clergy and the Brahman Teachers; an auspicious triple furrow is then cut all round a field, which has been previously decorated with garlands of flowers and various charms. The earth turned up by the plough is sprinkled with lustral water; sanctified seeds are scattered to symbolize the opening of the sowing season."

Rice in its original state, i. e. unhusked, is called Padi. There is a large number of fixed named varieties, but these may be classified into two main types, viz., Glutinous Rice and Non-Glutinous Rice. Glutinous Rice derives its name from the fact that it is sticky when cooked. Those varieties of Glutinous Rice with coarse, large, red, purple or blackish grains, form the staple food of the people in north and north-eastern Siam, while Non-Glutinous Rice

Harrowing.

Taking young plants from the nursery
for transplanting.

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constitutes the staple food of the rest of the Kingdom, as well as the principal article of export from Siam.

All the fixed named varieties which give us Glutinous and Non-Glutinous Rice are again divided, according to the custom of the cultivator, into three sub-varieties, namely :—

1) Khao Bao (Light Crop, *i.* e. early maturity), which ripens in $2\frac{1}{2}$ months from the time of planting;

2) Khao Klāng Pi (Mid-year Crop), which ripens in 3 or 4 months; and.

3) Khao Năk (Heavy Crop or late maturity), which ripens in 5 or 6 months.

There are two methods of planting, namely:

1) Wān (broadcasting), and

2) Dăm (transplanting).

For the first method, "Na Wān" (Na = a rice-field, and Wān = to sow), also called "Na Müang," the land is ploughed as soon as the rain has moistened the soil sufficiently for the plough to break it up, usually in the month of May. Soon after, the same ground is gone over again with a harrow drawn by buffaloes or bullocks, after which the seed is sown upon it. Another ploughing is necessary in order to turn up the earth to cover the seed. The field is then furrowed with an interval of 6 feet between the furrows, which serves as drainage during the germinating period. The seed will germinate soon after sowing and grows to maturity without further attention; but if the rain is heavy and the ground remains flooded, the seed will decay and re-sowing is necessary. Na Wān depends upon local rainfall, and the method of planting is not so elaborate as "Na Dăm."

For the second method, "Na Dăm" (Na = a rice-field, and Dăm, to dive into, hence, to plant with the hand in the soft-yielding mud) also called "Na Suan," the ploughing is done when sufficient water has collected on the field, either from rainfall or by irrigation, to cover the soil entirely. It is then churned into a porridgy mass and the weeds and grass removed by the harrow. In the meantime, the rice has been sprouting in the nursery, the manured soil of which causes rapid germination, and the young

plants are now taken up and planted out. The "Na Dăm" method is much more productive than the "Na Wān," and whenever a supply of water becomes available by irrigation or from excessive rainfall, the latter gives place to the former.

There is still another method of cultivating rice; in temporary forest clearings, on uplands, often on hill slopes. This kind of cultivation naturally has to depend entirely on rainfall. The rice so produced is only used locally.

In the Central Plain of Siam planting may be said to begin in May and to continue till October; in Northern and Eastern Siam it begins in June and continues till October; and in Southern Siam it extends from July to December. Harvesting takes place in the first named part of the country from September to January; in the second, from November to February; and in the third, from January to May.

The reason for these long continued operations is explained by the division of the padi into the three main sub-varieties mentioned above. A farmer will plant a certain area of the fast-growing varieties as quickly as possible. He will then prepare the remainder of his land, and afterwards continue to plant, first the main crop and then the most fast-growing varieties, as long as the weather remains propitious. The ideal climatic conditions in the various divisions of the country are as follows:—

For Central Siam a light rainfall in March, a dry April, rains in May and still lighter in June; heavy rain in July, August, September, and most of October, and thereafter none at all.

For the Northern and Eastern Circles the conditions should be more or less similar to the above; but for the Southern Circles, where the monsoon lasts from October to March (in contradistinction to the other parts of Siam), light showers in October, heavy rain in November, December and January, and light rain in February, are most desired.

If the rains in Central Siam are delayed until late in the season, as sometimes happens, there is still time to obtain a good crop of the "Bao" and "Klāng Pi" sub-varieties. But if the rains come too early and are thinly spread over the season, conditions

Transplanting.

Transplanting.

are usually bad; and two, or even three, sowings are often required to secure a mediocre crop.

The implements employed in rice cultivation are simple and primitive. These consist of a plough made entirely of hardwood, except the plough-share, which is a piece of iron of triangular shape, a little larger than the palm of a man's hand, and a harrow which is a rake with teeth made of hardwood and drawn by buffaloes or bullocks. The wooden plough is easily broken, while the steel plough imported from abroad is too heavy to handle and therefore has not replaced the wooden plough. A new plough, designed and constructed by the Department of Agriculture, which combines strength with lightness, is being used successfully on the heavy muddy soil of the Central Plain.

The high cost of machinery, the characteristic conservatism of the farmers and the fact that they are people of small means, are factors which militate against the adoption of machinery in farming. However, with the lead taken by the Government and the more enlightened and enterprising landlords, with the march of modern civilization and ideas, with greater demand for Siam rice from abroad, and with credit organizations such as are offered by the Co-operative Credit System, which is now beginning to take a hold in Siam, there seems to be no reason why these labour-saving appliances should not gradually play a more important part in the rice industry of Siam. Already healthy signs are in evidence. In the districts around Bangkok mechanical pumping machines for irrigation purposes have become more and more popular with the farmers, whereas a decade ago they still clung to the age-old waterwheels driven by man-power. Many people now actually make a living by hiring out their pumping machines.

While the padi is growing it demands no labour, and, until it is reaped, nothing is done beyond a little spasmodic bird-scaring by children. With the reaping time all are busy again. As a rule, each man ploughs his own land, but the planting and reaping are usually done with the aid of his neighbours, the whole village turning out and working together on each owner's field in turn. This labour in common is the occasion for much merry-

making, the young men and maidens, glad of the chance of meeting, planting and reaping all day amid bouts of repartee and bursts of laughter, and finishing up with a hearty feed at the expense of the owner of the field, followed by music and other amusements.

The crop is cut with small sickles, loaded on to carts or sleds and drawn to the winnowing ground, a small spot either in the fields or near the village, on which the earth is beaten down hard and smooth. There the sheaves are strewn out and are trampled upon by the cattle until the grain is all detached from the straw. Winnowing then takes place, after which the grain is stored in specially constructed huts, and the year's work is over.

An interesting point may be recorded as regards the harvesting of the crop. In the Northern, Eastern, and Central Circles, the reaping is done with a regular sickle applied low down on the stems of the plant, which are afterwards threshed: but in Southern Siam the method, said to be copied from the Malays, is to cut off each ear one by one with a small comb-knife held in the fingers, and then to tie the ears up in bundles for transporting.

Production of Rice

Siam is a large country with an area of just over 200,000 square miles, but at present only one-twentieth of this is under rice cultivation. Siam is now seriously embarking upon a policy of economic development on western lines; the country is being opened up by a net-work of railways and roads; more and more land is being brought under rice cultivation by systematic irrigation on an extensive scale, and the peasants are beginning to be put on a sounder economic footing by the Co-operative Credit System. It may thus be confidently hoped that during the next decade the rice crop of Siam will continue to show a greater yield year by year. In the last twenty years the area under rice-cultivation has increased almost twice.

The following Table shows the area under rice cultivation and the yield of padi for the whole Kingdom during the past eight years.

Threshing.

Padi ready to be loaded in railway trucks.

Year, Buddhist Era*	Area under Cultivation	Yield of Padi
	Acres	Tons
2464 (1921–22)	6,489,600	4,198,600
2465 (1922–23)	6,318,200	4,306,000
2466 (1923–24)	6,716,500	4,364,200
2467 (1924–25)	6,942,400	4,902,300
2468 (1925–26)	6,841,300	4,159,800
2469 (1926–27)	7,236,700	5,184,600
2470 (1927–28)	7,319,400	4,527,900
2471 (1928–29)	7,123,800	3,851,300
Total for eight years	54,987,900	35,494,700
Average	6,873,487	4,436,837

*The Siamese year begins on April 1st.

Marketing

The reader has already been made acquainted with the method of planting and harvesting; he will now be told how the Siamese farmer disposes of his padi, how it gets into the trade channels, how it is treated and how it ends its career.

The usual method of selling padi among the cultivators is to dealers who visit the various districts for that purpose. As a rule the cultivators do not sell direct to the rice-mills themselves. This is not because they do not want to do so, but because they have no means of doing so, the mills being situated far away from their lands. This is where the dealer comes in and shares much of the profit which should go to the cultivator. The dealers are not in the employ of the millers, but act independently as middlemen between the millers and the cultivators.

The basis of sale is by means of a measure called a "Kwien" (literally a bullock-cart), which in the trade is corrupted into "Coyan." This "Kwien" contains 80 baskets, which vary in content in different districts. By the new Law of Weights and Measures, which came into force optionally for five years on the 17th

December 1924, the "Kwien" is now fixed at 2,000 litres; and it is hoped that in time this measure will find general acceptance. It is of essential importance to the rice trade of this country that it should do so.

If the padi is grown on high lands, where there is no means of communication by water, the villagers have to bring it down to the railways or the nearest water-way by means of bullock carts. If the padi is grown on the low land where water communication exists, it is loaded at once in boats, and thus brought down by the dealer to the nearest local mill, or to one at Bangkok.

As padi is the most important product of the land, it naturally follows that rice-milling is the most important industry of the country. Until recently this industry has been confined to Bangkok, but with the country opened up by rail and road, rice-mills are now springing up in different parts of the land to the detriment of the Bangkok mills, and perhaps, of the dealers too, but to the economic benefit of the country.

The rice-mills of Siam, which are largely in the hands of the Chinese, are of four kinds, namely, those worked by (a) steam; (b) motor-power; (c) electric power; and (d) hand. The working of mills by hand dates, of course, from ancient times.

The average capacity of each of the first three kinds is about 136 tons per day. There are 71 rice-mills established in Bangkok, mostly on the banks of the river Menam Chao Phya, of which 59 are worked by steam, 2 by motor-power and 10 by electricity. It may be said, however, that all these mills are never working together at the same time; it is, indeed, common knowledge that there are too many rice-mills in Bangkok for the trade available, and the millers suffer in consequence. As far as the provinces are concerned the latest return shows that there are now over 500 mills working in different parts of the country. Most of these mills are driven by motor-power, but there are also a few driven by steam.

The millers being for the most part Chinese, the labour employed in their mills is, almost without exception, also Chinese. There is a regular traffic in coolies between Bangkok and the

Chinese port of Swatow, thousands coming and going in a single voyage.

As has already been explained, the cultivator classifies his padi into three varieties, namely Khao Bao, Khao Klāng Pi and Khao Nak; but the miller, when the same padi arrives at the mills, classifies it into:

1) Khao Na Suan, or Garden Rice, often quoted in the 'London and China Express' as Garden Siam, which is the best quality of miller's padi.

The grain is long, thin, full of fat (i. e. translucent), strong, and when well-matured, gives only a very small percentage of Broken Rice. The husk is thin. There are many fixed named varieties of this quality; it may be either "Bao", "Klang Pi" or "Nak," and in addition may be planted by either of the methods in use. It comes chiefly from the districts of Nakon Chaisi, Rangsit, (near Bangkok) and Sakae Krang (Utai Tani).

2) Khao Na Müang or Field Rice, which is the lowest quality of miller's padi. The grain is short and broad, wanting in fat (i. e. opaque); hard, and inclined to be brittle, especially when not well-matured. The husk is coarse and thick. The fixed varieties that give this quality are mostly of the sub-varieties "Nak" (heavy) only, and it is sown broadcast (Wān) upon land subject to high flood. The typical Na Müang plant grows as the water rises, ripens while practically floating on the surface of the water, and can be reaped from boats. A considerable percentage of the husked grain of this quality is pink in colour. Khao Na Müang comes chiefly from the Ayudhya, Ang Tong, Pak Hai, and neighbouring districts.

3) Khao Sam Ruang, or Three-eared Rice, which is a quality of padi rather superior to Khao Na Müang, presents similar characteristics, but it contains a certain percentage of long grain and, when husked, the pink grains are fewer. This quality is all sown broadcast, "Wān", but the fixed varieties that give it are subdivisible into "Bao," "Klāng Pi" and "Nak".

4) Khao Bao, or Light Rice, is a better quality still than Khao Sam Ruang. The percentage of long grains is higher, and

the pink grains are almost entirely absent from the husked grain. It is sown either by transplanting or broadcasting, and the fixed varieties are divisible into "Bao," "Klāng Pi" and "Nak." This Khao Bao must not, however, be confused with the cultivator's classification of the same name.

5) Khao Nio or Glutinous Rice, as a miller's term, does not include the coarse, large, red-purple, or blackish-grained varieties that form the staple food of the northern provinces. It refers to the superfine fixed varieties of that species that are grown in small quantities in various districts of the Central Circles, for example, Nakon Chaisi and Rajaburi. These varieties are milled in small private mills for local consumption, or for export in small consignment to Singapore and to the Dutch East Indies. Its price usually rules on a par with the best Na Suan Rice, but special lots of peculiar aroma and consistency sometimes command much higher prices still, this constituting the best table rice obtainable in the country.

The classification of padi according to the miller's qualities is a matter of high expert knowledge, every consignment of padi offered for sale being carefully examined and classified before purchase. The business of classification is made the more difficult by the fact that a single consignment will often comprise the widely divergent produce of several farms.*

The cultivator's and miller's classifications of padi have now been given, and here it remains to deal with the padi after it has been milled and has become rice.

Milled Rice is divided into three broad categories, namely, WHITE RICE, WHITE BROKEN RICE, and MEAL.

WHITE RICE is sub-divided by the trade into five grades, viz :—

1) Super (containing not more than 5% broken)
2) Special (containing not more than 15% broken)
3) Ordinary No. 1 (containing not more than 25% broken)
4) Ordinary No. 2 (containing not more than 50% broken)

* Khao Na Suan and Khao Bao supply the mills with as much as 90% of the total deliveries, the former about 70% and the latter about 20%.

5) Ordinary No. 3 (containing not more than 75% broken)

WHITE BROKEN RICE, which comprises all White Rice containing more than 75% broken, is of four qualities, namely, A1, C1, C3 and C4.

MEAL is of two qualities: White Meal and Cargo Meal.

In the home market, rice is sold in two ways:

a) by contract, fixing the price, the quality, the time of delivery and the amount required. This is wholesale selling, and the miller usually delivers the rice ex wharf.

b) without contract, when the rice is sold retail, and the buyer usually fetches his rice from the seller. In a locality where only water communication exists, the seller usually takes a good supply of rice in a boat and paddles it along a canal offering to sell his rice to any household that may be in need of it.

The qualities of rice consumed locally are Ordinary No. 1 (15% to 25% broken), and Ordinary No. 2 (25% to 50% broken). In the North of Siam, the rice consumed is almost entirely Khao Nio, or Glutinous Rice. There is, however, nowadays a tendency to substitute the non-glutinous for the glutinous quality.

In this connection it may be of interest to give here a brief description of the Siamese method of cooking rice. The process is as follows. Once the rice has been put in the pot, usually an earthen pot, cold water is poured on it, and the rice is washed in the pot itself. This water is then drained off and a new supply put in, just enough to cover the rice. The pot is then set upon the fire. As soon as it comes to the boil, the contents are skimmed and stirred. After boiling for a few minutes longer, and as soon as the grains swell and begin to burst, all the water is drained off and the pot is set on the charcoal fire to steam in order to complete the cooking. In this manner the rice will swell up to its full, and when removed from the fire it is almost dry, with the grains intact (i. e. not sticking together as in the case of glutinous rice) and possesses a delicate flavour.

As regards the export market, the trade with Hongkong and Singapore is largely in the hands of the millers themselves, as they have agents in one or both of those ports, and ship in accordance

with arrangements made. The Europe trade is almost entirely in the hands of European firms. Sales are effected by samples previously submitted, and contracts are usually made forward, but a certain amount of rice is shipped to Port Said, or Alexandria, for orders, i. e. its ultimate destination is unknown to the buyers at the time of purchase. The chief qualities exported are White Rice (5 qualities), White Broken Rice (4 qualities), Cargo Rice (roughly husked rice) White Meal and Cargo Meal, Parboiled Rice and Glutinous Rice: while there is a small quantity of padi exported as well.

The port of sale is Bangkok, except for the local southern trade, and there are two methods of shipment. Steamers with shallow draught, which can cross the bar at the mouth of the Menam Chao Phya come up to Bangkok and load directly at the mills, which are situated on its banks. Larger vessels with deep draught anchor at the island of Koh Sichang, 19 miles from the bar, and load the rice there from lighters which convey it from Bangkok.

The principal countries to which Siam rice is normally exported are as follows:—Singapore and Hongkong including China Ports, which take about 75% of the total; Europe (chiefly the United Kingdom, Germany, together with Port Said and Alexandria for orders) Japan, the Netherlands Indies, and the West Indies (Cuba). Before the War, Germany (Hamburg) was a very important customer, but she has not yet regained her former position. Small quantities are also shipped to the British Malay States, Holland, Denmark, Italy, France, Belgium, South Africa, India and Formosa.

There has latterly been a serious falling-off in the export of Siamese rice to Europe and Cuba, as compared with pre-war days, and the cause is stated to lie in the deterioration in quality of rice supplied. This state of affairs is now being carefully investigated.

CHAPTER XIII

OTHER CROPS

It is so obvious that Rice is the life-blood of Siam and the cultivation of padi overshadows all other crops to such an extent that one is liable to forget their existence. Nevertheless these crops are of great importance and will be considered briefly in this chapter.

Rubber

The planting of rubber, *Hevea brasiliensis*, in Siam on a large scale is of comparatively recent occurrence and very few of the estates were in bearing or even in existence at the time of the great boom in the Federated Malay States in 1912.

The climate in most parts of the country is unsuitable for the cultivation of Hevea owing to the low rainfall and long dry period in between the rains, but the conditions are favourable over a small area in South-eastern Siam near the coast, as well as in the southern part of Peninsular Siam. There are a few registered companies owning rubber plantations, but for the most part the blocks of trees are small and owned by individuals. One of the largest and most important of these is an estate in Chantaburi, where there are trees reputed to be 20 years old. This estate is

2,000 rai in area, 500 of which are in tapping. In 1929 it was producing 600 piculs of rubber a month.

The following table shows the number of rubber trees in various districts in 1929.

NUMBER OF RUBBER TREES FOR THE YEAR B. E. 2472 (1929-1930).

Circle	In Tapping	Immature	Total number of trees
Chantaburi	2,781	7,514	10,295
Nakon Sritamarat	85,495	80,899	166,394
Pattani	139,041	273,291	412,332
Puket	30,725	60,177	90,902
Total	258,042	421,881	679,923

The total area in tapping in that year was 258,042 rai (103,216 acres), and the export of rubber (excluding rubber waste) was 5,027,159 kilos., valued at 2,956,485 Ticals. If the amount exported represents the whole production, the yield per acre is only about 110 lb., a very low figure that might be due to conservative tapping or more probably to the tapping of immature trees.

Coconuts

The coconut palm thrives well throughout the whole of South-eastern and Peninsular Siam.

It was at one time largely grown round Bangkok and inland in Central Siam, but the ravages of the coconut beetle (*Oryctes rhinoceros*) and its ally, the red weevil, have been so enormous that it is now grown on a very limited scale in those parts of the country. The ravages of these pests have extended into Eastern Siam and whole plantations have been wiped out in a single year by their voracious appetites.

Coconut planting in Peninsular Siam has been taken up by Siamese capitalists; here the palms flourish exceedingly, particu-

larly near the sea coast, which is generally recognised as its natural habitat. The island of Koh Samui off the east coast of Peninsular Siam is famous for the quality of its coconuts.

The coconut palm prefers a light alluvial soil, not too sandy, but will grow on well drained clays. The soil must be of sufficient depth (at last 60 cm) to allow of good drainage.

The coconut usually comes into bearing between the fourth and seventh year after planting, but the dwarf coconut comes into bearing after three years only. The chief advantages of the dwarf coconut are its hardiness, early maturation, and its high productiveness; but it has the disadvantage attendant on the handling of the larger number of small fruit.

Yield

The average yield is about 45 nuts per palm and the present price (1930) about 4 to 8 Tcs. per 100 in Bangkok.

The table given below shows the number of palms registered in the principal coconut growing circles.

Circle	2471 (1928-29)			
	Trees in bearing	Trees not yet in bearing	Total	Number of Coconuts
	No.	No.	No.	No.
Puket	293,608	273,498	567,106	10,013,080
Chantaburi	143,304	116,398	259,702	4,998,785
Nakon Sritamarat	1,391,386	1,555,472	2,946,858	48,495,435
Patani	859,838	799,989	1,659,827	30,011,505
Prachinburi	153,521	46,869	200,390	4,281,790
Rajaburi	1,848,872	102,308	1,951,180	54,541,800
Total	4,690,529	2,894,534	7,585,063	152,342,395

These figures must be considered incomplete, as they do not include the circle of Krungtep (Bangkok) and other circles where the palms are very scattered in their distribution. The export of

copra in 1929-30 was 273,246 piculs, valued at Tcs. 3,657,412.

According to the above figures 4,690,529 palms yielded 152,324,395 nuts, an average of about 32 nuts per tree. This is lower than the actual yield, as no account is taken of the very large number of unripe nuts that are picked for the sake of the cool refreshing drink provided by the "milk" contained therein. Let the unwary traveller be warned, should he stop for a drink, to accept only the green unhusked nut, and to see that the top is slashed open in front of his eyes. Do not accept a husked nut with a dirty brown exterior, or the liquid inside may prove a sad disappointment, being warm and insipid. These are nuts that have been roasted over a fire to facilitate the removal of the husk, and the shell, being a good insulating medium, retains the heat in the milk for a long period.

Sugar

In the first half of the last century sugar was produced on a large scale, and in 1859 the export reached 12,000 tons. Since then the amount exported has rapidly dwindled until 1929-30, when only 592 piculs passed through the Customs. One of the reasons for this decline has been the extension of padi cultivation at the expense of cane plantations, rice yielding a better profit. Furthermore the home grown sugar has not been able to compete with the cheaper sugar imported from Java.

In common with the other sugar producing countries of the world the industry in Siam was dealt a smashing blow by the sugar beet, but whereas many of the other countries recovered Siam did not. The final collapse has been brought about by the general overproduction of sugar, particularly in Java, where the new high yielding strains have been introduced all over the island.

Siam imports annually 40 million kilograms of refined sugar, but even so it is doubtful whether it would be worth while attempting to revive the industry, as the difficulties in the way of economical manufacture and marketing would be very great.

There are now only about 20,000 acres devoted to sugar

cultivation, mostly small Chinese owned plantations in the province of Chonburi.

A great quantity of sugar cane is eaten as a sweetmeat, and some of the less saccharine varieties are very palatable, having a faintly acid flavour. The hard rind of the cane is shaved off and the sticks are cut into short pieces about 1½ inches long. These, sometimes impaled on a slither of bamboo, are presented for sale by the itinerant vendor on railway stations or in the streets.

The observant traveller will notice bundles of sugar cane being carried about in rickshas or laid out for sale in the market, and may mistake them for sticks of bamboo with tufts of leaves on the top. The cane varies in colour from green and yellowish green to a dark purple. Small plantations of sugar are noticeable in and round Bangkok; tall graceful grasses with long leaves marked with a longitudinal central white line.

Besides cane-sugar, a certain amount of palm-sugar is made, but it is mostly consumed in the country. The toddy palm *(Borassus flabellifer)* is the most important source of these sugars; but the nipa palm *(Nypa fruticans)*, the arenga palm *(Arenga saccharifera)* and the coco-nut palm are also tapped for this purpose.

Cotton

Cotton has been cultivated in Siam from time immemorial, and there are a great number of indigenous varieties. Sir George Watt suggests that the original cotton of Siam is a variety (*Gossypium Nanking var. siamensis*), with either white or coloured floss, which is the common cotton cultivated in Northern Siam, its cultivation extending down to Kanburi Province. Cotton is grown in the Northern, Eastern and North Central Circles, but nearly the whole output is consumed locally. The area under cultivation is now only 9,000 acres, yielding 33,000 piculs. The average annual export of raw cotton for the five years ending March 31st 1930 was 6,982 piculs, valued at Tcs. 88,539. It is probable that these figures also include kapok.

AREA AND YIELD OF COTTON CROP IN THE YEAR B. E. 2471 (1928-29)

Circle	Areas Rai	Yield Piculs	Yield per Rai Piculs
Nakon Rajasima	13,070	17,271	1.32
Pitsanulok	2,125	3,196	1.50
Payap	3,617	5,464	1.51
Udorn	3,915	7,003	1.79
Total	22,727	32,934	1.45

One of the chief difficulties in marketing the cotton from Siam was found to be that the lint was of mixed origin, of all lengths and strengths. Unginned cotton was similarly heterogeneous, which made the product almost useless.

The Department of Agriculture imported seed from Cambodia, India, and Egypt and introduced it to the cultivators, but unfortunately no effort was made to keep the seed pure, and now all the strains are mixed.

There is no doubt that there is room for a large development of cotton plantations in Siam, if suitable foreign seed is selected and the cultivators can be assured of a market for their crops.

Tobacco

This crop is not much grown in the Great Central Plain or Peninsular Siam, but otherwise it occurs as a casual crop almost everywhere. The heaviest yields are obtained on the light rich alluvial soil on the banks and islands in the upper reaches of the Menam Chao Phya and its tributaries, in the far northern circle of Payap and eastern circle of Korat. Other important tobacco growing areas are Pitsanulok in the north and Rajaburi, southwest of Bangkok.

The Siamese being persistent smokers, a great part of the crop is consumed locally, in addition to large quantities of American and Chinese made cigarettes, which are imported to the annual value of over 8 million ticals. There is, however, some export of tobacco, the average annual amount for the five

years ending March 31st 1930 being 13,751 piculs, valued at Tcs. 825,599.

Nakon Rajasima (16,573 rai), Pitsanulok (11,255 rai) and Payap (13,029 rai) were the circles with the largest areas under tobacco in B. E. 2471 (1928-29). The total area cultivated in that year was 62,246 rai (25,000 acres) with a yield of 115,127 piculs (15.3 million lbs.)

There is no doubt that good cigarette tobacco can be grown in this country, particularly in the northern circles, and the big foreign tobacco companies might well consider the possibility of starting their own local factories in conjunction with experimental farms.

Some preliminary experiments have been initiated by the Department of Agriculture in growing cigarette tobacco from imported seed; three varieties from the U. S. A., acclimatized in Philippines; one variety direct from the U. S. A. and one from China. These seeds were planted in the Chiengmai district in three localities; the best yield coming from a plot on the higher slopes of Doi Sutep.

The experiments are to be repeated next season in the more northern district of Chiengrai.

Sesamum

Sesamum, or teel, as it is sometimes called, is cultivated very widely all over Siam, but chiefly in the Ayudhya and Pitsanulok Circles, which together account for more than half the crop. Rajaburi Circle produces the next largest amount.

There are now 10,000 rai (4,000 acres) under this crop, producing 25,493 piculs. A small amount of the seed is exported; the average annual amount of the export for the five years ending March 31st 1930 being 2,030 piculs, valued at Tcs. 21,315.

This plant is sometimes grown in rice fields in certain parts of the country, Rajaburi Circle and elsewhere, during the early part of the year and is harvested in time to prepare the land for the reception of the padi. The value of the crop lies in the seed, which contains an oil much prized for cooking purposes. The residue after

pressing out the oil is useful as a food stuff for cattle, or fertilizer for the soil, by virtue of its content of nitrogenous matter.

Beans

The crops of leguminous seeds are sometimes listed as 'Beans and Peas' or 'Peas'; but, as a matter of fact, most of the large crops come under the heading 'Beans.' True peas are only grown to a small extent, and they are not exported.

A large variety of beans are grown for local consumption, but only a few are exported. The most important of the latter are: ground-nuts (*Arachis hypogoea*), green gram (*Phaseolus radiatus*), cow-pea (*Vigna sinensis*) and soy-bean (*Glycine max*). The area under these crops is 23,476 rai (9,394 acres), yielding 75,298 piculs. The biggest producer is Rajaburi Circle, followed by Nakon Sritamarat and Nakon Sawan.

In the five years ending March 31st 1930, the average amount of the annual export was 4,921 piculs, valued at Tcs. 41,663. Singapore takes over 95% of this export.

Pepper

W. A. Graham in his book on Siam says "The cultivation of pepper is one of the most ancient agricultural industries of the country. As far back as history goes, it has been an article of export and, in mediaeval times, it formed part of the complimentary gifts sent to foreign countries by embassies from the Court of Siam. In the seventeenth century the monopoly of the pepper trade was one of the chief chronic causes of contention between the foreign merchants in Siam, and it was largely by giving this to the French that Faulkon, shortly before his downfall, hoped to strengthen their position, and incidentally his own, in the country. At that time the output of pepper was probably about three thousand tons a year, and since then it has varied very much, rising at times to more than double that figure and at others sinking to almost nothing."

Thus pepper cultivation is, like sugar, a declining industry. In 1919 there were 24,000 rai still under pepper, but by 1923 this had fallen to 9,500 rai. Similarly during the same interval the yields have dropped from 57,000 piculs to 25,000 piculs. This

Picking pepper, Chantabun.

decline may be attributed to a drop in the prices obtained coupled with unscientific methods of cultivation and careless preparation of the commodity. In later years the industry in Chantaburi has suffered extensively from various diseases of the pepper vine. Nearly the whole area under cultivation now lies in the Chantaburi Circle, only about 6% of the crop coming from the other two pepper-producing circles, Nakon Sritamarat and Puket.

In 1928-29 the area was 11,388 rai (4,555 acres) and the yield 30,692 piculs, which represents a slight recovery since 1923. The average annual export for the five years ending March 31st 1930 amounted to 12,490 piculs, valued at Tcs. 945,930.

The soil in the pepper growing districts is generally a chocolate coloured laterite, very loose and with a fine texture. Chemically these soils are richer than most of the other Siamese soils. Propagation is usually by cuttings 2–2½ ft. long, taken from the upper part of the vines. These are planted direct in the pepper garden, about 2 metres apart, only 9 inches remaining above ground, and are protected from the sun by means of dried leaves.

The soil of the garden is dug over to a depth of 2–3 feet previous to planting. Where water is available the plants are regularly irrigated by means of channels between each row; thus the plants remain on a ridge, which is about 1½–2 feet higher than the bed of the channel. The first picking of the berries takes place after the third year. The fruits in previous years are not allowed to form. Picking is done only once a year, from January to April. The maximum yield is obtained after six years from planting and the vines continue to give a paying crop for a further period of six years.

Diseases and Pests. A serious menace to the industry is the fungus, allied to the fusarium wilt, which has already resulted in completely destroying many gardens, especially in low lying areas. Another serious pest is a black bug *(Elasmognathus sp.)*. It sucks the sap out of the young berries and flowers, causing widespread damage. In some localities the roots of a wild plant called "kapiet" *(Stemona Collinsae)* are used, in the form of an aqueous extract, for the control of this pest, in many cases with

a high measure of success.

Maize

Small fields of maize are seen everywhere in the country. It is far more generally grown than would appear from the official returns. When a cultivator clears the jungle and plants hill padi (kao rai or kao pa) he sows maize in between the rice, and every villager has his patch of Indian corn, if the soil is at all suitable. The biggest area under this crop is in the circle of Nakon Rajasima; no other circle can approach it, the nearest being Nakon Sritamarat and Udorn. The figures for yield per rai must be considered as being very much on the low side, for the unripe cereal with its soft milky grain is considered an indispensable dainty in the ordinary household, and "corn-on-the-cob" is a regular accessory to the normal diet of the people, high and low.

In the year B. E. 2471 (1928-29), the total area under maize was 46,331 rai, with a yield of 176,960 piculs. The largest crops were obtained in the Circles of Nakon Rajasima (59,927 piculs), Udorn (37,171 piculs) and Nakon Sritamarat (34,467 piculs).

Chillies

A great number of varieties of chillies are grown, from the large, green mild 'prik yuak' to the small, red, pungent bird-chilly or 'prik ki nok'. When grown to any extent, chillies are planted in forest clearings. Some of the most extensive plantations are to be found in the provinces of Sawankalok, Saraburi, Korat and Nakon Nayok.

The export of dried chillies is subject to wide fluctuation; for instance in the year B. E. 2471 (1928-29), only 53 piculs were exported, while in B. E. 2472 (1929-30) the export was 4,114 piculs. In the five years ending March 31st 1930, the average annual export was 1,494 piculs, valued at Tcs. 22,108. Singapore takes 90% of this export.

Areca-nuts

There is quite a large area planted with areca, but no official figures of its extent are available. Nearly every peasant grows a few areca-palms, if his soil is at all suitable, but these are simply for his own use. In some districts, however, the areca is grown

for the market. There are large plantations in Chumpawn, Langsuan, Surat, Patalung, Nakon Sritamarat and other provinces.

The export of the dried nuts is considerable, but very variable, as is also their market value. In the five years ending March 31st 1930 the value of the annual export has been as high Tcs. 1,600,000 and as low as Tcs. 250,000. The average annual export for that period was 69,579 piculs, valued at Tcs. 913,099.

Cardamoms

The export of cardamoms from Siam is classified under two headings, 'best cardamoms' and 'bastard cardamoms'. Bastard cardamoms are the product of one or more species of *Amomum* growing wild. This class comes almost entirely from Eastern Siam.

'Best Cardamoms' are probably derived entirely from cultivated plants; the species that yields them being *Amomum Krervanh*. This plant is chiefly grown in the provinces of Chantaburi and Krat. Plantations are made in the forests, often in mountain valleys. In making these plantations the forest trees are not felled, but some clearing of the undergrowth is done.

In the five years ending March 31st 1930 the average annual export of 'best cardamoms' was 1,118 piculs, valued at Tcs. 234,417. In the same period the average annual export of 'bastard cardamoms' was 4,061 piculs, valued at Tcs. 205,418. Hongkong takes most of the export of both qualities.

Bananas

Bananas are becoming an increasingly important crop in Siam, the largest areas of cultivation being in the provinces of Lower Siam.

A large number of varieties are grown. The most extensive plantations, however, are nearly all of one variety, known as klui nam wa. This variety, though not accounted among the finest table bananas, is very palatable, and has certain other advantages. It is very hardy and can grow under drier conditions than most other varieties. It is also the best variety for sun-drying. When well sun-dried it will keep for months and might be exported in this form*.

* An account of some of the varieties of banana grown in Siam will be found in the Journal of the Siam Society, Natural History Supplement, Vol. VIII, No. 1 (1929).

Onions

Onions are largely planted in Nakon Chaisi and Rajaburi Circles. They are exported chiefly to the Straits Settlements and British Malay States. The annual amount of the export for the five years ending March 31st 1930 was 151,423 piculs, valued at Tcs. 512,893.

Menglak

Menglak is the Siamese name of sweet basil *(Ocimum Basilicum)*. The plant is universally grown, the seeds being chiefly used for flavouring drinks and making sweetmeats; they have the property of swelling into a mucilaginous mass in water.

The seeds exported are from plants grown in Lower Siam. The average annual export of these seeds in the five years ending March 31st 1930 was 1,572 piculs, valued at Tcs. 20,353. The bulk of the export goes to Singapore.

Lotus

The lotus *(Nelumbo nucifera)* is cultivated wherever suitable ponds are available. It is grown both for its economic products and as an ornamental plant. Several parts of the plant are used; the petals are dried and used for wrapping cigarettes, while the tubers and seeds are articles of food. The seeds are, however, the only part exported. In the five years ending March 31st 1930 the average annual amount of this export was 1,456 piculs, valued at Tcs. 44,937. Nearly all the export goes to Singapore and China.

Kapok

Kapok trees may be found all over Siam, generally occurring singly or in small groups round the home of the villager. The peculiar appearance of the tree, almost leafless in the dry season, with stiff horizontal branches and trunk with conical spurs, make it easily recognisable, particularly when the large cylindrical pods are brown and ripe, with white cotton-like fluff showing through the cracked husk. Kapok has been grown sporadically for a long time, and it is only since 1919 that any attempt has been made to produce more of it than was required for the immediate use of the villagers.

There are a number of other crops, at present of minor im-

portance, and for which there are no figures available. Coffee is one of these. It has been grown to a small extent in Northern Siam for some years, and recently one or two large plantations have been started. There is a small overland export of the beans from Northern Siam to French Indo-China. In Chantabun coffee has been successfully grown for many years, but only in small quantities, which usually get no further than Bangkok. The cultivation of tea is referred to in the chapter on Minor Industries, under the heading 'Mieng.'

Ginger *(Zingiber officinale)* and turmeric *(Curcuma longa)* are grown a good deal in the region round Bangkok, and in Nakon Chaisi Circle. Turmeric is also grown as a crop in the provinces of Korat and Buriram. Manioc or tapioca *(Manihot utilissima)* is extensively grown, particularly in the southern provinces of Peninsular Siam. When the tapioca has been extracted the refuse is sold as pig-food. Most travellers on the Southern Line will have noticed, or at least smelt, the wagons loaded with this refuse. In the year B. E. 2471 (1928-29) the Railways carried over 7,000 tons of it. Taro *(Colocasia esculentum)* is commonly cultivated round Bangkok, chiefly by Chinese. At least one medicinal plant is grown as a small crop in the Bangkok region; this is red plumbago *(Plumbago rosea)*, whose roots are exported to China.

Fruit Gardens

The principal fruits grown in Siam are, first of all, the mango, of which many varieties are known, the most luscious being the delicately flavoured "ok rong" with pale yellow, almost white flesh.

Following this in importance are the citrus fruits. The citrus fruits of Siam have never been exploited properly. There are a great number of varieties, from the tiny lime, the size of a small hens egg, to the large and luscious pomelo, a close relative of the grape fruit. The limes are utilised locally for curries and cooling drinks, while the pomelo is valued as a table delicacy. The Nakon Chaisi seedless pomelo is famed all the world over and many unsuccessful attempts have been made to introduce it into the Philippines and other countries, with its many excellent

qualities intact.

No less than 8.7 million of these fruits, valued at over 600,000 Ticals, were exported in the year 1929-30. The annual value of the export of other fruit varies from about Tcs. 270,000 to Tcs. 490,000.

In view of the embargo on the exportation of limes and lime juice from Italy, there is a big shortage of citrus products in Great Britain. It would be worth while considering the question of the development of acid-lime growing on a commercial scale.

The sweet pungent odour of the durian penetrates obtrusively the atmosphere of the gardens in which it grows and the village streets where it is sold. Few who have overcome their repugnance to the powerful scent and sampled the fruit can resist the appeal of this wonderful fruit.

Other important fruits grown are Jack fruit; Pineapple; Mangosteen; Tamarind; Papaia; Bread fruit; Water-Melons of a high quality; Custard-apple; Pomegranate; Guava; "Katawn" (*Sandoricum indicum*); "Chompu" (*Eugenia malaccensis*); "Lam Yai" (*Nephelium longana*); "Luk Ngoh" (*Nephelium lappaceum*); "Lin Chee" (*Nephelium Litchi*); "Maprang" (*Bouea burmanica*); "Mafuang" (*Averrhoa Carambola*); "Langsat" (*Lansium domesticum*); "Luk Wa" (*Eugenia cumini*); "Mafai" (*Baccaurea sapida*); "Sala" (*Zalacca Wallichiana*); "Lamut" (*Achras Sapota*); and many others of less importance.

Market Gardens

There are extensive market gardens in the environs of Bangkok, most of which are run by Chinese. Among the vegetables grown in these gardens, apart from those already mentioned, are:—tomatoes, brinjals, the greater and the lesser yam (*Dioscorea alata* & *D. esculenta*), bean-yam (*Pachyrhizus angulatus*), beet-root, sweet potato, radish, cabbage, lettuce, garlic, celery, coriander and numerous others. In the north of Siam, in the cold weather, many European vegetables and flowers can be grown which do not do well in Lower Siam.

CHAPTER XIV

LAC CULTIVATION AND TRADE

Lac is a product containing a dye and a resin which are obtained from the lac insects. Formerly, the lac-dye only was utilised, as a substitute for cochineal. After the discovery of aniline, the lac-dye became of little value, but when methods of using the resin had been found, the latter became a very important article of international trade.

The most important lac producing countries are India, Siam and French Indo-China.

Siam supplies sticklac, i. e. raw lac only, as there is no production of any kind of manufactured lac. An endeavour, however, has been made in the past few years to manufacture garnetlac, but this industry has not been much developed.

Siam lac has been an important cultivated product for many years, and in spite of the recent fall in price, it is still a steady article of export.

For the ten years up to 1924 the World's production of lac averaged annually 386,000 piculs, of which Siam supplied 15,000 piculs. In the next five years period the annual production went up to 535,000 piculs, 40,000 being from Siam; of the remainder India supplied 478,000 and Indo-China 17,000 piculs.

The Cultivation of Lac

Lac is cultivated in the Northern and North-Eastern regions, viz., in the Circles of Payab, Nakon Rajasima (Korat) and Udorn, and in a small percentage, in the Circle of Pitsnuloke. The cultivation has been tried in the central part of Siam, but without any practical result.

The lac cultivators generally employ wild trees, except *Cajanus indicus* and *Pithecolobium saman*, which are now regularly planted. They propagate lac on trees in forests and fields and do not employ hired labour. Most of them are rice cultivators, and lac cultivation, which consists of 5 to 30 trees, is only a side occupation. The tree most employed in the Circle of Payab is *Butea frondosa*, while *Albizzia lucida* and *Combretum quadrangulare* are much used in the provinces of Nan, Prae and Lampang.

The second category of lac growers is the small merchant, who propagates lac on 40 to 150 rented trees. He leaves the trees to the care of proprietors and gives them a share of the yield obtained.

The real lac growers generally rent trees from the rice cultivators at 2 to 4.50 Baht per tree, per year. Most of these trees are *Pithecolobium saman*. Each lac grower uses from 50 to 450 trees and employs labour, as in a real plantation.

Cost of Production

From an investigation conducted by the Economic Enquiry Section, Ministry of Commerce and Communications, the cost of production of a picul* of lac obtained from *Pithecolobium saman* is 20 to 26 Baht. It may be higher for lac grown on *Butea frondosa* and *Albizzia lucida*, as these trees are distant from each other and yield less than *Pithecolobium saman*. The cost of production of the latter may be calculated as follows:—

Rent of 100 trees	Baht	200–450
Brood-lac (3 piculs)	,,	210–300
Labour	,,	250–250
	Total: Baht	660–1,000

* 1 picul = 133 1/3 lbs.

Propagating lac on *Pithecolobium saman*.

The total yield being from 25 to 45 piculs, the cost of production is from 20 to 26 Baht per picul of lac obtained.

From the above calculation, it will be seen that the rent of the trees is a rather high item of expense. If, instead of renting them every year, lac is grown as a plantation product, the cost of production will be much less.

Food Plants

There are about thirty species of food plants for the lac insects in Siam, most of which are wild trees. The most important are: *Butea frondosa, Albizzia lucida, Pithecolobium saman*, commonly known as rain tree, *Cajanus indicus* and *Combretum quadrangulare.* Beside the above, *Dalbergia spp., Ficus spp.*, and *Zizyphus jujuba*, are also used as food plants.

The lac cultivators now realise that it is more advantageous to grow lac in a regular plantation than to propagate it on wild trees, as the latter are situated at irregular distances from each other, sometimes shaded by other trees and damaged by black ants or wild animals. Furthermore, lac is liable to be stolen in the collecting season.

The trees which are now planted for the propagation of lac are *Pithecolobium saman* and *Cajanus indicus*, others being only in an experimental stage.

Plantations of Pithecolobium saman

Plantations of this tree are now widely adopted, especially in the region of Chiengmai. It is said to be easily sown and that it grows rapidly. As to the growing, it much depends upon the soil in which it is planted. If the soil is friable and fresh, the tree may be used within five years and thereafter every year, for the boughs grow very rapidly. If the soil is bad and dry, it requires sometimes more than ten years before the tree is ready for the propagation of lac, and after a crop is collected, it is necessary to wait for 2 to 3 years before it can be used again. This tree yields an average of 25 to 45 catties * of lac. In Chiengmai a five to six years old tree yields between 15 to 100

* 100 catties = 1 Picul, or 133 1/3 lbs. av.

catties, and a nine to ten years old tree gives from 50 to 200 catties. Sometimes, from a tree of over 15 years, which, by the way, can seldom be found, five to six or even seven piculs of lac are obtained. According to experiment, *Pithecolobium saman* must be planted at least 20 metres from each other. In some plantations, where the 20 metres distance is not observed, the lac insects feed only upon outer trees. The distance between trees is a very important point, as *Pithecolobium saman* has dense foliage and numerous long boughs, which after ten years, reach about 32 metres in length. Beside it is necessary to take into consideration the fact that the lac insects need air and sunlight.

Plantations of Cajanus indicus

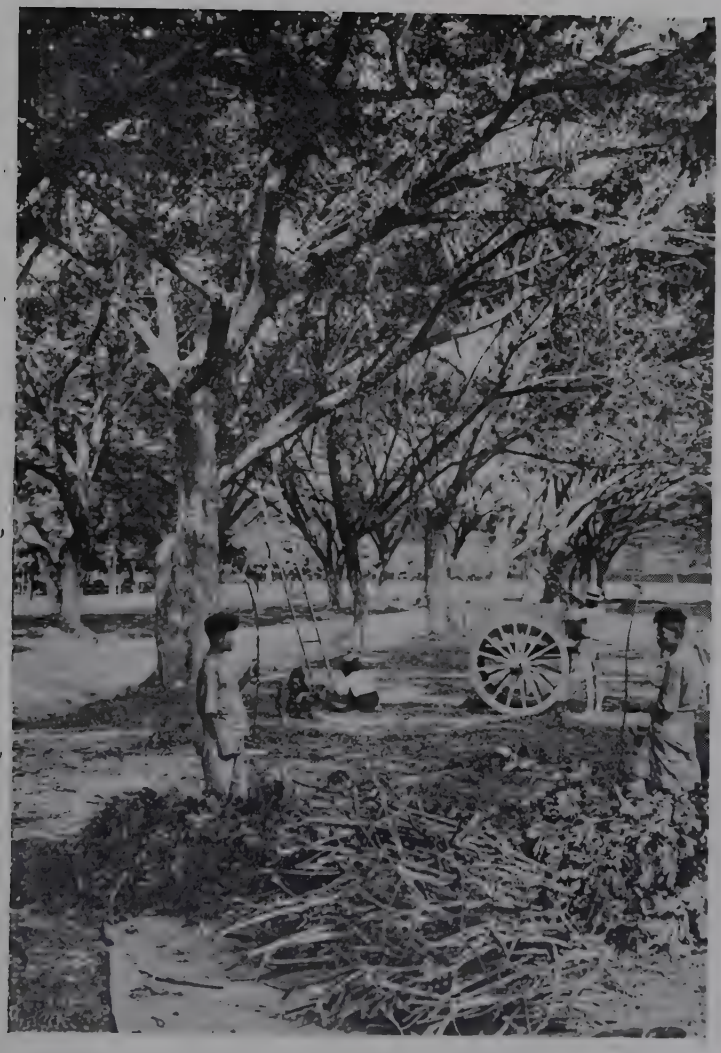
Plantations of this tree are made mostly in the Circle of Payab. It is easily sown, and, unlike *Pithecolobium saman*, it does not require a particular soil. A soil, fresh, friable and containing a large quantity of lime, is considered a good soil for *Cajanus indicus*. In the Circle of Payab, these trees live from 3 to 4 years. They are planted 4 metres from each other and can be used within 2 to 3 years. If they are well looked after, they yield about 2 piculs per rai.* This is the Burmese system. In the provinces of Chiengrai, Prae and Utaradit, the Luang Prabang system prevails. This consists of planting trees at a distance of 2 metres from each other and of propagating lac within six to ten months. This is done twice, after which the trees are cut down, and new trees are planted again. This system of lac growing yields about ten to twenty catties of lac per rai.

Trade in Siam Sticklac

Export of Sticklac

Sticklac is, among the cultivated minor products, one of the most important articles of export, its quantity and value increasing very steadily. The following Table will give a clear idea of the progress of the trade in this product for the last twenty-two years.

* 2½ rai = 1 acre.



Lac collecting.

EXPORT OF SIAM STICKLAC

Period	Quantity Piculs	Value Baht
B. E. 2451-2455 Annual average (1908-09 to 1912-13)	7,859	197,174
B. E. 2456-2460 Annual average (1913-14 to 1917-18)	10,526	385,539
B. E. 2461-2465 Annual average (1918-19 to 1922-23)	17,086	1,317,332
B. E. 2466-2470 Annual average (1923-24 to 1927-28)	33,353	2,399,121
B. E. 2471 (1928-29)	57,436	3,925,716
B. E. 2472 (1929-30)	86,729	4,758,405

From the above figures it will be seen that the increases, both in quantity and value, were considerable. From 3,500 piculs in B. E. 2451 (1908-09) the quantity of sticklac exported rose to 86,700 piculs in B. E. 2472, and the value from 135,300 Baht to 4,758,400 Baht, or over 3,000%. From a small product sticklac has become one of the most important.

The principal countries importing sticklac from Siam are Singapore, India, the United States of America, Germany and the United Kingdom.

In the twenty year period B. E. 2451-2470 (1908-09 to 1927-28), the proportion of Siam lac going to different countries has varied a good deal. While the amount going to Singapore has dropped from 75% to 53%, that to the United States of America has risen from 0.1% to 27%, and to Germany from 6 3% to 12 3%.

The above figures show that Singapore is the most important buyer; sticklac exported to this port is re-exported to other countries, chiefly to India, where it is amalgamated with local lac. Direct exports to countries using sticklac, namely Germany and the United States of America, are now increasing. According to information received, sticklac sent to the United States is mostly used in the manufacture of gramophone records and insulating material, while it is employed in European countries in the manufacture of varnishes.

Sources of Supply

Siam sticklac comes from the Northern and North-Eastern provinces and from some districts of French Indo-China. Practically the whole production is exported to foreign countries; the local use is insignificant, being confined only to the manufacture of lacquerware and to cotton and silk dyeing, in districts where articles of clothing are woven by the inhabitants themselves.

The most important market is Bangkok, where sticklac is sent down from the provincial markets, viz., Chiengmai, Lampang, Korat, Utaradit, Denjaya.

Characteristics of lac from different sources.

1. Chiengmai lac.—This is the best of all Siam lac, as it is very carefully collected and contains a very small quantity of dust and wood. About 90% of this lac is grown in this province, and is obtained chiefly from *Butea frondosa* and *Pithecolobium saman*. The remainder comes from Chiengtung and some districts of Chiengrai and Mehongsorn.

2. Chiengrai lac.—This lac, which contains a little more dust and wood than that of Chiengmai, is chiefly supplied by foreign provinces, namely Chiengtung, Sip Song Panna, Yunnan and Luang Prabang, the local production being only about 10%. The local lac is obtained from *Butea frondosa*, while foreign lac is propagated on *Ficus spp.*, *Dalbergia spp.*, *Butea frondosa* and *Cajanus indicus*. Chiengrai lac is exported sometimes direct to Bangkok and sometimes through Lampang, Prae and Utaradit. and is known in the Bangkok market as Lampang lac.

3. Lampang lac.—Not more than one half is the local production, which is obtained from *Albizzia lucida*. The greater part of Lampang lac comes from Chiengrai and is of foreign source. Some districts of Lampoon, Chiengmai and Chiengrai supply a very small quantity. Lampang lac is exported direct to Bangkok.

4. Prae lac.—This lac has the same quality as that of Chiengmai. It contains a small quantity of dust and wood, and obtains a good price in the market. The local production is about 75%, the rest is supplied by the province of Nan and some districts

Separating lac from twigs.

of Chiengrai. The production of this province is very small, as compared with that of other provinces, and forms about 5% of all Siam's lac.

5. Utaradit lac.—Lac cultivation in this province is only in the experimental stage. Utaradit is a transit market and receives lac from Nan (obtained from *Albizzia lucida*), Luang Prabang and Pak Lai (obtained chiefly from *Cajanus indicus*).

6. Korat lac.—As to quality, Korat lac comes last, being much adulterated with dust and wood. It is supplied by the Circle of Nakon Rajasima (Korat), chiefly the provinces of Ubol and Roi Et, and by the Circle of Udorn and, some time ago, by French Indo-China. Korat lac is obtained principally from *Combretum quadrangulare* and, in a small percentage, from *Dalbergia spp.*, *Ficus spp.*, *Zizyphus jujuba* and *Cajanus indicus*. Formerly its quantity equalled that of Chiengmai lac, but it has gradually decreased since some of the foreign lac is now passing through Utaradit and Lampang.

Classification of Lac

In the Bangkok Market, lac is classified into two categories: the Northern lac and the Eastern lac. The former obtains a better price than the latter.

This classification is made regardless of the quality of lac, that is to say, without taking into consideration the species of trees the lac is obtained from. Lac that contains a large quantity of dust and wood is considered as a bad quality.

Dust and wood which are found to be mixed up with lac are the result of carelessness when cutting the twigs down, especially in the Northern-Eastern Circles. The other cause of dust and wood is dependent on the lac itself. If the crusts of lac are of small size, they are not taken out from the twigs, lest they should be crushed into small pieces or reduced into dust. The size of the crusts varies according to the trees on which lac is grown. The large crust measuring about 2 inches in circumference is from *Butea frondosa*, *Pithecolobium saman* and *Albizzia lucida*. The small crust, of about half an inch circumference, is from *Combretum quadranguiare*, *Dalbergia spp.*, and *Ficus spp.* Lac from *Cajanus*

indicus has small and large crusts which can easily be separated from the twigs, and so contains no dust and wood. As stated above, the Eastern lac is in great part grown on *Combretum quadrangulare*, and consequently contains a large quantity of dust and wood. The Lampang lac, the greater part of which is of foreign source and which is obtained from *Dalbergia spp.*, and *Ficus spp.*, contains a small quantity of dust and wood, while the Chiengmai lac, which is grown on *Butea frondosa* and *Pithecolobium siman*, has a negligible quantity of dust and wood.

In the five years ending March 31st. 1930 the average price of Chiengmai lac has varied from 44.40 Baht per picul (in B. E. 2469, 1926-27) to 73.90 Baht per picul (in B. E. 2470, 1927-28). While in the same period the Korat quality has ranged from 42.40 Baht to 63.10 Baht. In B. E. 2472 (1929-30) the average price for Chiengmai quality was 50.80 Baht and Korat quality 49.00 Baht per picul.

Classification of Lac according to Trees

As stated above, in Siam and French Indo-China, no classification of lac is made according to the trees on which lac is grown. But in India, which is the most important lac producing country, the classification is as follows:—

1) Lac from *Schleichera trijuga* is the best of all lac, as it has a clear colour and is used in the manufacture of Shellac Standard I.

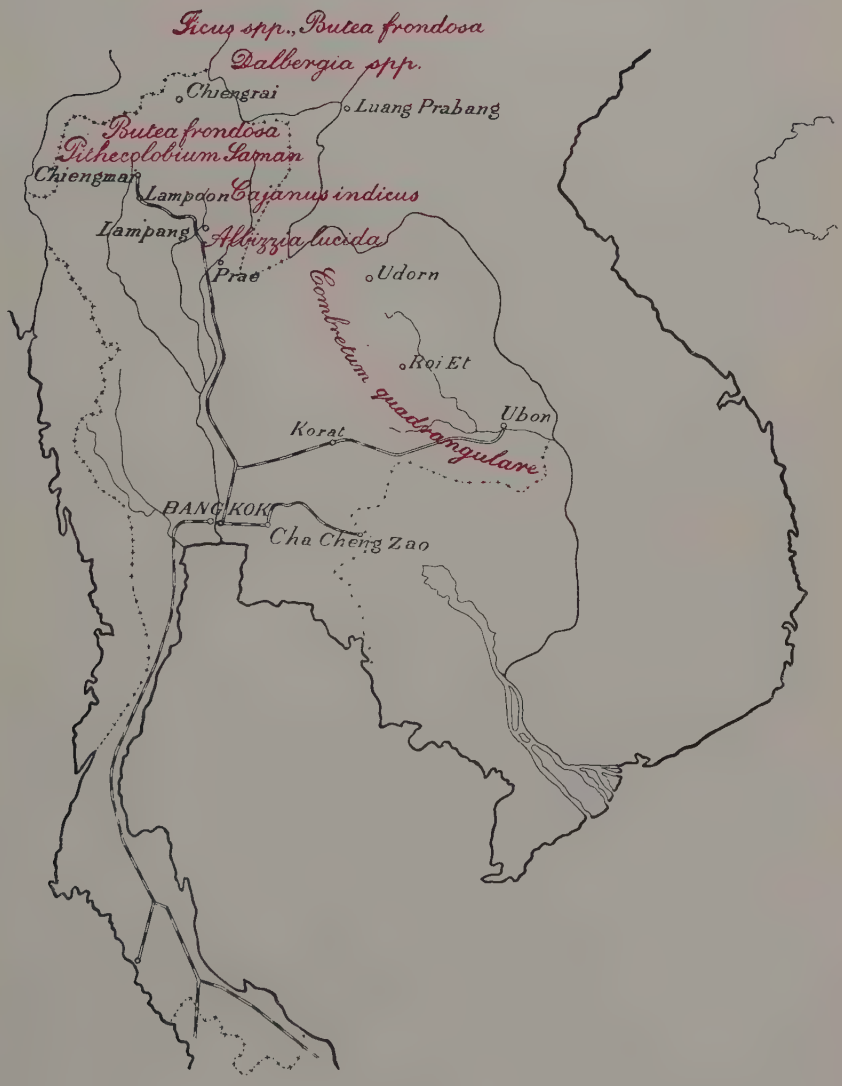
2) Lac from *Butea frondosa* is of the ordinary quality, its colour, although red, may easily be bleached.

3) Lac from *Cajanus indicus* is considered to be of a bad quality, as its red colour is not easily bleached. This kind of lac is generally used in the manufacture of Garnetlac and Buttonlac.

From the above classification, it does not follow that the price of the superior lac must always be higher than that of the inferior one. In the London and New York markets, the price of the best lac is generally 10% higher than that of the inferior lac. But now and then the latter is quoted higher than the former. It often happened that the price of Garnetlac was 45% and that of Buttonlac 20% higher than that of T. N. Shellac. This is due

MAP OF SIAM

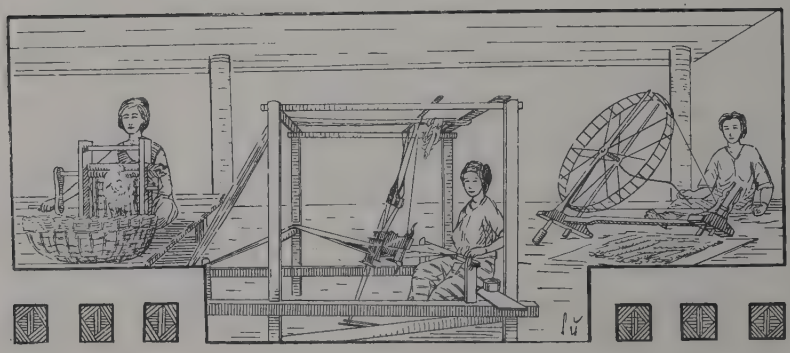
Showing trees employed in the cultivation of Lac in different regions



to the fact that lac is used for various purposes. A manufacturer who has always used the Garnetlac, generally refuses to buy Shellac Standard I, although the latter is of a better quality; still there is a greater demand for the former. When there is a shortage of Garnetlac, the manufacturer will accept Shellac Standard I at a lower price.

As each quality of lac is considered a distinct kind, it is necessary to know which lac is most in demand. Some fifteen years ago, lac of inferior quality was used in the manufacture of common varnish, while the fine varnish was made from Orange Shellac. The best lac, i. e. the bleached Shellac, was also used in the manufacture of fine varnish, and as an ivory substitute. Consequently, the inferior quality was quoted very low. But since lac has been largely employed in the manufacture of gramophone records and insulating material in electric appliances, the ordinary and inferior lac are more in demand with an ever increasing price. In the United States, where lac is largely used, the quantity of bleached shellac employed per annum is only about 10% of the ordinary and inferior lac.

The fact that lac of ordinary and inferior quality is more in demand than that of superior quality, is a great help to the lac cultivators in Siam to succeed in this trade, as the material conditions do not permit them to cultivate lac which could be used in the manufacture of Orange Shellac Standard I. From Siam lac, ordinary Shellac, Garnetlac and Buttonlac could be easily obtained. Thus Siam lac can readily find a market. And there is an increasing demand from foreign countries, such as the U. S. A. and Germany.



CHAPTER XV

MINOR INDUSTRIES

In Bangkok there are many industries carried on more or less on a large scale, such as electrical engineering, dock-works, cement-works, soap-making, match-making and tanning, besides the all important rice-milling. It is not proposed to treat of these in this chapter, which will chiefly be concerned with industries carried on in villages or in small urban houses, rather than in factories.

Many of these local industries are, unfortunately, on the decline, owing to the import of cheap, foreign, factory goods; but there are still a few in a flourishing condition.

A very successful attempt to revive and improve many of the indigenous handicrafts has been made by the Arts and Crafts School in Bangkok, which turns out yearly numbers of highly trained craftsmen.

Dyeing

Not so many years ago local vegetable dyes were in use in nearly every village. Nowadays, however, aniline dyes have penetrated to the remotest hamlet, and they offer such a variety of colours at so low a price that they have ousted many of the vegetable dyes.

Mat-weaving, Chantabun.

There are a few, however, which are still employed and which are exported in one form or another. Perhaps the most famous of these dyes is sappan-wood, usually mentioned in old voyages as brasil-wood. The very name Brasil, or Brazil, is interesting. Its etymology is doubtful, but it seems to have been originally applied by Portuguese and other East-Indian traders to this wood. Later a similar wood was found in America, and from that circumstance the country of Brazil took its name.

Sappan-wood is the heart-wood of a small thorny tree, *Caesalpinia sappan*, found in many parts of Siam, but most abundantly in the provinces of Ratburi, Petchaburi and Prachuap, In these provinces the wood is still collected, but the export is now small and restricted to China. It yields a red dye.

At the present day the largest dyeing industry is concerned with the maklua berry, the product of a large forest tree, *Diospyros mollis*, which also yields ebony. These berries give a fast, black dye, which does not damage the fabric. They are in local use in Northern and Central Siam, as well as in the northern part of the peninsula. In addition to their local use there are several large establishments in Bangkok where silk is dyed with these berries. The great drawback to their use is that they must be used fresh, and in the green, unripe state; once they are allowed to turn black, they are useless for dyeing purposes. This is got over to some extent by keeping the green berries immersed in water, which lengthens somewhat the time that they can be kept. It has not yet been found possible to make an extract, or to export the dye in any other form than dyed material This being the case, silk is imported for the special purpose of being dyed by the maklua berry, and then re-exported. The method of dyeing which gives the best result is a very slow one, and may take more than a month to complete. The berries, pounded into a paste, are mixed with water, which is then strained, the resulting liquid being the dyeing solution. Nothing else is added at first, but for the last dippings a little lime is also put in. Into this liquid the material to be dyed is dipped, then spread out to dry; when dry it is dipped again, and again spread out to dry. This

alternate dipping and drying goes on till the material acquires a deep black colour. At least one hundred dippings are required to attain this result from white material. If the weather is bright and sunny, as many as ten dippings can be done in a day, but in wet weather the process is very slow; and it is chiefly in the rainy season that the work has to be carried on, as it is then that the fruit comes into season. A faster method, which does not give such good results, is to dye the material first with some other dye.

In the five years ending March 31st 1930 the average annual amount of black silk, dyed with maklua berries, exported from Bangkok has been 52,326 rolls, valued at Tcs. 1,004,167.

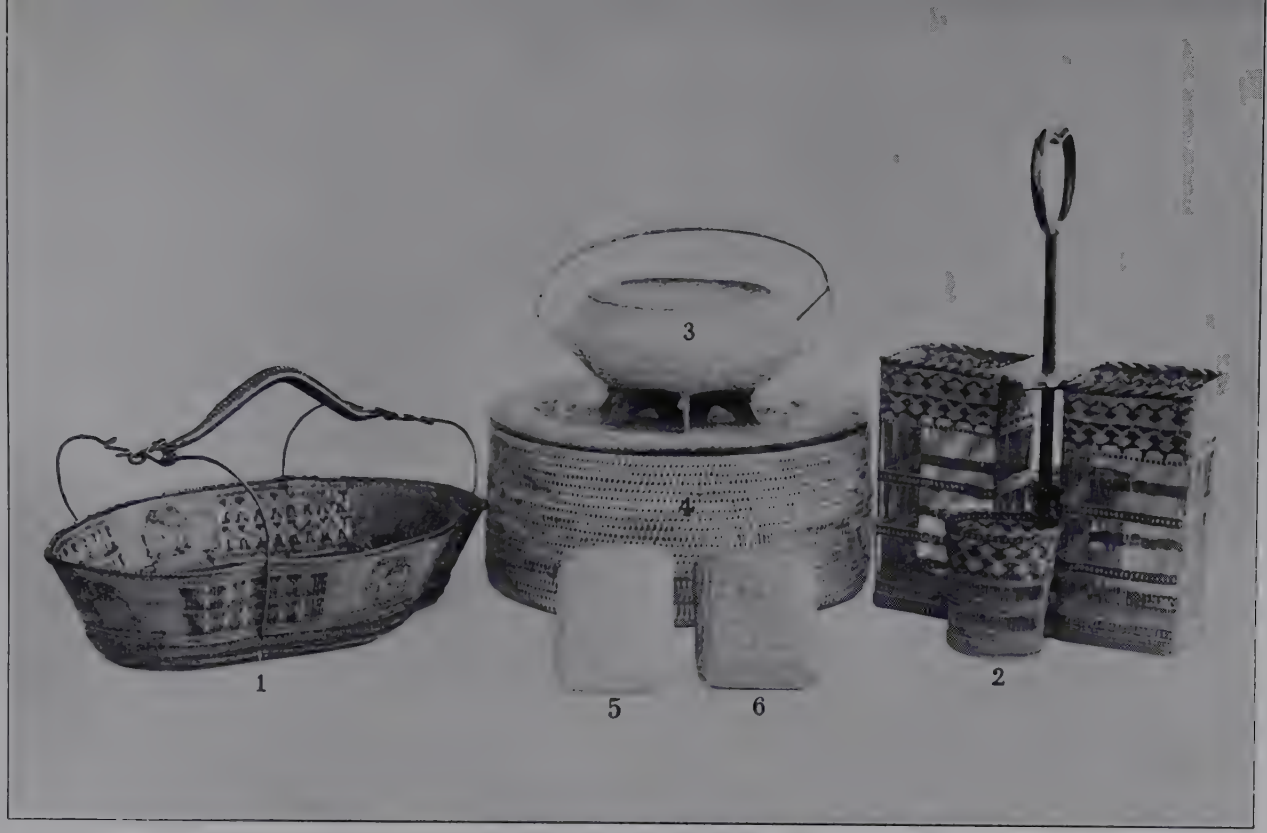
Another dye that is exported, and whose export has greatly increased, is the heart-wood of a spiny climber, known as kê lê, a species of *Cudrania*. This wood yields an orange dye. Most of it goes to Java, especially for use in the batik industry. Upwards of 100 tons of this were exported in the twelve months ending March 31st. 1930.

There are numerous other vegetable dyes still in use, but now only in a very small way. Among the more important are:—blue dyes—leaves of *Strobilanthes flaccidifolius*, *Indigofera tinctoria* and *Indigofera Anil*; red dyes—roots of *Morinda tinctoria*, seeds of *Bixa orellana*, fruit of *Mallotus philippensis*; yellow dyes—heart-wood of the Jack (*Artocarpus integrifolia*) and the bark of *Garcinia Vilersiana*. One of the commonest red dyes, though not strictly of vegetable origin, is lac.

Weaving

At one time weaving was universal throughout Siam, but the importation of cheap foreign material has gradually ousted home-made cotton and silk, except in a few localities. During the war, however, when the supply of foreign material was uncertain, a number of hand-looms were started in Bangkok and other large towns by the Chinese. These looms allow of much quicker work than the primitive looms formerly in use, and they are still being employed to a large extent.

Apart from these Chinese looms, cotton weaving is now nearly confined to Northern and Eastern Siam, except for a few



Basket Work

1 & 2. Articles made of stems of climbing fern (*Lygodium salicifolium*).

3 & 6. Articles of fine bamboo work.

4. Box of rattan work.

5. Cigar case made with peacocks' quills.

outstanding places like Chantabun, Krat and Anghin. In Northern Siam and Eastern Siam both foreign yarn and yarn from locally grown cotton are used. The resulting material is rather coarse, but very durable. There is one variety of cotton, grown in Northern Siam, in which the floss is naturally of a khaki colour instead of white, and this makes a very serviceable khaki cloth.

Most of the silk weaving is done in Eastern Siam, where nearly every village that is away from the main lines of communication, rears silk-worms and prepares its own silk. In such villages the common wear of the poorest is silk. For ordinary every day wear rather coarse material is used, but much finer silks are woven for sale. The weaving is done on the same type of hand-loom as is used for cotton. At one time there was a considerable export of woven silk from certain districts of Eastern Siam, particularly from the provinces of Korat and Buriram, to Burma, but this trade has fallen off very considerably since Burma put an import duty on silk. In Northern Siam, chiefly near Chiengmai, some silk weaving is also done, but the raw silk is imported.

Basket-work and Mat-making

Nearly every villager is an adept at making rough baskets and mats from bamboo. The coarser kinds of baskets can be made in an hour or so, but these are not durable, for, even if not soon worn-out, they are quickly attacked by wood-boring insects. For better and more durable work precautions have to be taken; the bamboo is first steeped for some time in water and the finished article often gets a coating of some kind of varnish. Very fine work can also be done with bamboo.

Rattans of various kind are often used for making baskets, sometimes alone, sometimes mixed with bamboo, and these are usually much more durable than those of bamboo alone.

Rattan and bamboo are also woven into hats, which may then be covered with cloth or the leaf of a palm (*Corypha sp.*). The resulting hat is very light and much used, in one form or another, by villagers who have to spend a long time in the sun, for instance in rice-planting.

Small articles, like cigarette or cigar cases, are often woven

from grasses. One rather curious material used for this purpose is the quills of the large tail-feathers of the peacock. Not only are small-articles like cigarette-cases woven out of these quills, but also hats.

But perhaps the finest basket-work of all is that made from the stem of a climbing fern, *Lygodium salicifolium*. Only small articles are made in this way.

Various materials are used for weaving mats, bamboo being the commonest of these. A skilful worker can make mats of bamboo as fine as those of almost any other material used. Rattan mats, plain or interwoven with the fibre of a climbing *Bauhinia*, are also in common use. Other materials used are the stems of *Schumanniathus dichotomus*, a white-flowered plant growing in marshy places, leaves of various species of screw-pine or *Pandanus* and leaves and stems of certain grasses and sedges.

Among the best known mats are those woven by the Annamites of Chantabun, from the stems of a kind of sedge *(Cyperus tegetiformis)*, which is grown specially for the purpose. By dyeing the fine strips of sedge different colours, various patterns are produced. The sedge strips are interwoven with fibre from rhea grass *(Boehmeria nivea)* to insure flexibility.

Under this heading may be put the various articles made from the leaf of the corypha palm. Hats have already been mentioned, but perhaps the chief use of these leaves is in making the palm-leaf manuscripts still in use by Buddhist monks. These leaves are also made into a variety of brightly coloured toys, used for hanging over babies' cradles.

Lacquer-work

The basis of all lacquer-work is rak, the black, treacle-like, oleo-resin obtained from the rak tree *(Melanorrhoea usitata)*, better known, perhaps, by its Burmese name, thitsi. This can be used either on a foundation of wood or of plaited bamboo-work.

When bamboo plaiting is used as a foundation, the bamboo-work has to be very neatly done with very fine bamboo slips. Most of this preliminary work is done by women and girls, who are very skilful at it. The plaiting is usually done on a wooden

Chiengmai Lacquer Work

1. Stages in making a lacquer box.
2. Bowl, engraved lines in white.
3. Water jar, pattern of applied gold leaf.
4. Bowl, engraved lines in gold.

mould, cut to the shape of the article required. The bamboo work is treated with a 'filling' of rak, padi-husk ash and very fine earth, to fill up the interstices of the plaiting. This may be applied in several layers, being smoothed down between each, till a quite smooth, even surface is obtained. The article now receives several coats of pure rak and is polished. With a wooden foundation, which already has a smooth surface, 'filling' is not required. When this stage is reached a design is usually put on. There are two methods of doing this.

One method is that commonly used by the lacquer-workers of Northern Siam, and is usually applied to small articles with a bamboo foundation, sometimes also to those made of wood. In this the artist engraves the design with a fine steel style, going through the outer coats of rak to the grey ash-mixture beneath. When the design has been so engraved the whole article is painted over with a mixture containing red-lead, rak and oil. This is allowed to dry and then the surface is rubbed down till all the red has been removed except that left in the engraved lines. A coat of varnish, a mixture of oil and rak, now finishes the article. Or, after the engraving has been done as before, a coat of rak is put on, and before this is dry gold leaf is laid on and well pressed down so as to enter the engraved lines. When the whole is dry all the gold is rubbed off except that remaining in the engraved lines.

The other method of applying the design to lacquer work is usually employed for large articles, particularly those with a wooden foundation, such as book-cases, doors and cabinets. Occasionally it is also used for small articles. It is the method commonly followed in Bangkok. In this no engraving is done, but the design is painted on the article, which has been finished off with rak as before. A yellow pigment, compounded of gamboge and other ingredients, is used for painting on the design. This pigment is painted on those parts which are finally to appear black; so, when the pigment has been applied, the design is, as it were, a 'negative' of the finished pattern. When the pigment is dry a light coat of rak is applied over all, and

then the whole surface covered with gold-leaf, evenly pressed on. The surface is now washed, when the gold-leaf overlying the pigmented portions all comes away, together with the pigment, leaving the black rak, while the gold leaf over the unpigmented portions remains.

Paper-making

The Royal Survey Department have installed modern machinery for paper-making, using for the most part waste paper and rags. Apart from this, rough unglazed paper is made in the Bangkok district and also in Northern Siam.

In Bangkok the paper is made from the bark of a tree known as koi, *Streblus asper*. The bark is brought to Bangkok in bundles of dried strips. These are soaked for three days in water, when the inner bark is separated by hand from the outer. The inner is reserved for the finest quality paper, the outer for second and third qualities.

After the different qualities of bark are separated, they are treated with lime-water for two or three days, then steamed for two days. The bark after this treatment is kept steeped in water till required for use. When it is to be made into paper the bark is carefully gone over, any rough or bad bits being removed, and washed in water. In the next stage it is pounded into an even pulp with a wooden mallet.

The trays, or moulds, consist of a wooden framework, about seven feet long by two feet wide, across which is tightly stretched a coarse cotton cloth, or rather fine net. The tray is floated in water; then a ball of pulp is taken, put in a bucket full of water and thoroughly kneaded till the fluid resembles a thick soup, which is then poured on the tray, still floating on water. A second ball of pulp is treated in the same manner. The tray is now lifted slowly out of the water, without tilting; an even deposit of pulp being left at the bottom. The surface of the pulp is gone over two or three times with a small, smooth roller. This removes superfluous water and improves the surface. When quite dry the paper is peeled off and is then ready for the market; unless a finer grade is required, when it is treated with starch and lime, and the surface polished

A Chiengmai potter.

with smooth stones.

The bulk of this paper is made up into folding books and sold to Chinese merchants in Sampeng, the Chinese quarter of Bangkok. About 5 sheets of paper, that is the sheets as stripped off the trays, go to one book. The books are sold at about 40 to 50 satangs each.

In the North of Siam the bark of the paper-mulberry (*Broussonetia papyrifera*) is used, and treated in a somewhat similar way. This paper is tougher, softer and whiter than that made from koi. The paper-mulberry is well known in other Eastern lands, and has been used since ancient times in the Pacific Islands for making cloth. A certain amount of this bark is sent to Japan each year, it is said, for the purpose of making cloth. In the year ending March 31st 1930, about 130 tons of this bark were brought down to Bangkok, presumably for export.

Pottery

Rough red earthenware is made in many parts of the country, chiefly for local use. There is some export of earthenware jars, made in the northern districts of Bangkok.

In Chiengmai a green glazed ware is made and is sold over a fairly large area.

Much finer work can be, and is occasionally done, but as the demand for it is so small, it seldom comes on the market.

White clay, used for pottery, is found in several districts, for instance, near Chiengmai and Udawn; but whether or not it is suitable for fine pottery is not known.

Metal-work

In spite of the simple apparatus used by the craftsmen, some forms of metal-work have reached a high standard. Some of the alloys used are very attractive, such as nak (a red gold) and samrit (a black bronze).

Iron is mined to a small extent in some districts, but most of that used in this country is imported. In the year ending March 31st 1930, 1,370,620 Kilos. of iron in the rough were imported. It is employed chiefly in making priests' bowls, agricultural implements and weapons. The making of priests' bowls is a rather

large industry, as might be expected when it is considered that there are over 130,000 priests in the country, and that each priest must have a new bowl when he enters a monastery, even if it be only for a week.

Bronze is much used in making images of Buddha, statues of priests, bells, gongs and bowls. Images, statues and bells are cast. In the first place a rough model of the required article is made in clay, over this is laid a layer of wax (a compound containing a good deal of bees-wax). This wax layer is carefully moulded to the exact shape required, and over this again is put another layer of clay, some pins being put in to keep the model steady in the later processes. The whole is now heated till all the wax flows out, through a hole left for the purpose, when molten brass is poured through other holes into the mould and left to set.

There is some industry in the beating out of brass bowls, a small number of which are exported every year. In the five years ending March 31st 1930, the value of the average annual export of these bowls was Tcs. 42,948. This export seems to be declining.

The gold and silver *repoussé* work of Siam is well known, most of it being done in Bangkok and one or two of the larger towns.

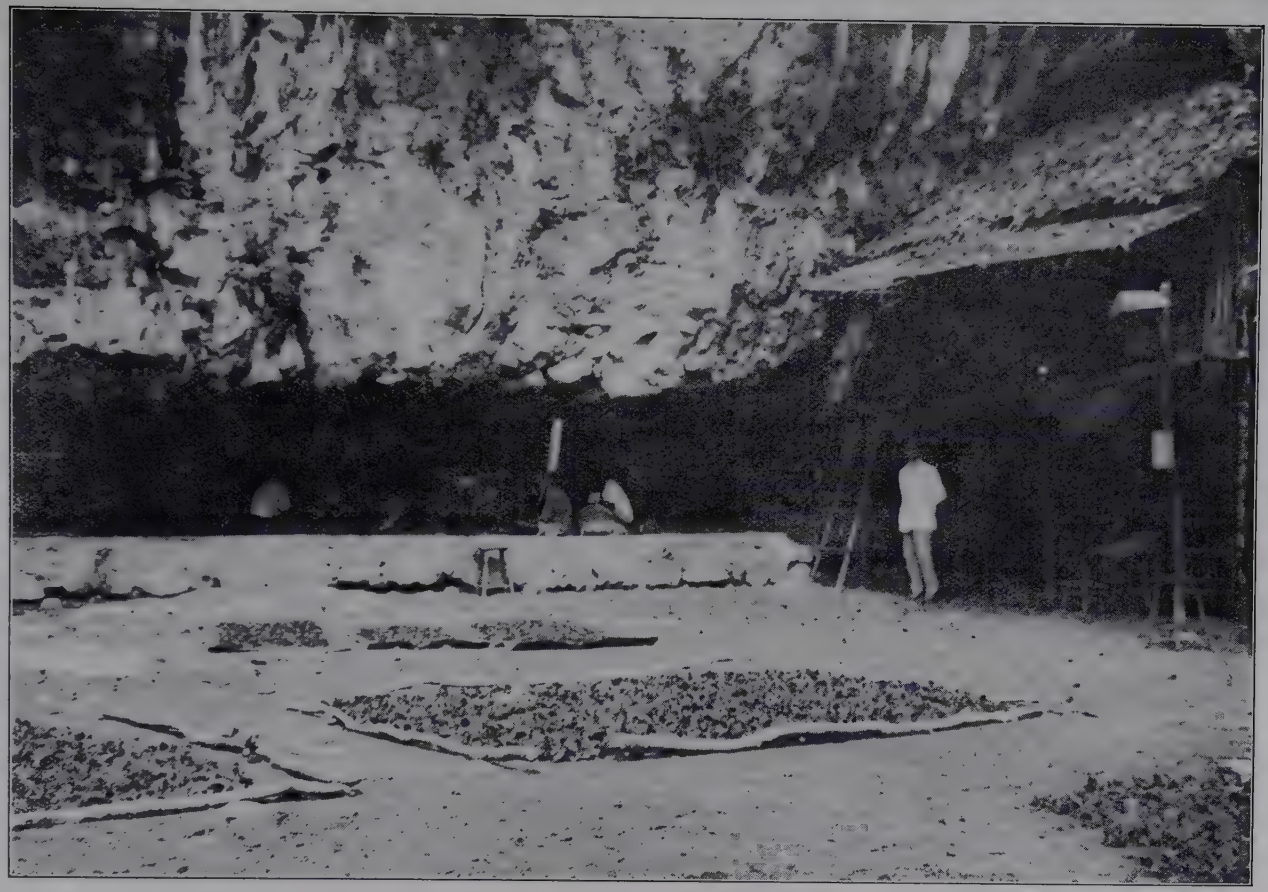
Niello-ware is another form of metal-work for which this country is famous. Bangkok and Nakawn Sritamarat are the two chief centres for its manufacture. This ware consists of silver inlaid with a black alloy, containing lead, sulphur, copper and silver. Gilding is often applied also.

There yet remain certain industries which do not, like the above, come under the category of handicrafts. The more important of these will be considered here.

Mieng

Mieng is the name for a kind of fermented tea, much in use in Northern Siam, and in which there is a considerable inland as well some transfrontier trade.

The plant from which this tea is obtained is the same species as that which yields Chinese and Assam tea, *Camellia theifera*,



Sorting birds'-nests.

and belongs to the large-leaved Assam type. Though most of the crop of leaves is obtained from cultivated plants, there seems little doubt that the species is also truly wild in Northern Siam, as it has been found in untouched forests on remote mountains, not near any habitation.

The chewing of fermented tea-leaves by the Siamese and Burmese probably dates back to very early times, as is suggested by their use at ceremonial functions.

The young leaves only are picked, and as they are picked they are tied up into small bundles, each about as much as the hand will hold. At the end of the day the pickers bring all their bundles into the village, where they are steamed in a large utensil. After steaming the bundles are turned out into open-work baskets and allowed to cool, when the fastenings of each bundle are re-tightened. The bundles are now tightly packed into bamboo joints, or baskets lined with banana leaves. The mieng is left in these containers for about a month, when it is ready for use. When it is to be sent to a distant place the mieng is packed directly into bullock-packs, so that when it reaches its final destination, often a month's journey or more from the mieng gardens, it is ready to be used.

In Northern Siam mieng is, for the most part, chewed with salt. It has a stimulating effect like tea, and enables a man to carry on a considerable time without food.

About seven years ago a rough estimate of the trade for five groups of mieng gardens in Northern Siam gave the annual output of mieng at 1,503,000 bundles, valued at Tcs. 206,625; but in this estimate several mieng centres were left out, so it is probable that the value of the trade is much greater than this.

Edible Birds'-nests

The trade in edible birds'-nests is an important one, the export all going to Chinese markets.

These nests are built by a small swift (*Collocalia* sp.) in limestone caves on islands off both coasts of the peninsula, and occasionally on the mainland, where limestone cliffs abut on the sea. The nest is apparently formed from a salivary secretion of the bird,

and is firmly stuck to the rocky wall of the cave. The best nests are small, gelatinous like, white cups. The collecting of these nests is let out each year to the farmer, who may again sub-let different islands to other agents. The actual collecters of the nests follow a very hazardous occupation, as the nests are often in caves or small crevices high up on limestone cliffs, and have to be reached by means of ropes and ladders. Fatal accidents to collectors are not at all uncommon. The nests are collected three times in the breeding season, the first collection produces the best nests and the third the worst. The latter are often mixed with feathers and other debris. After the third collection the birds are allowed to build for a fourth time and to bring out their broods; but these nests are often so hastily built, perhaps because the bird has exhausted its secretion, that the young birds frequently fall out and are left to die on the floor of the cave. In addition to the above nests there is another variety made in similar situations, often in the same caves, by another species of bird, but these nests are always much mixed with feathers and have a very small market value. In the five years ending March 31st 1930, the average annual export of edible nests was 361 picul's (21,660 kilos), valued at Tcs. 386,127.

Salt

Most of the salt is obtained from sea-water, the chief salt pans lying round the head of the Gulf of Siam. As in other places the salt water is pumped on to the pans and then allowed to evaporate. The same methods of raising the sea-water are used as in irrigating rice-fields.

In several places inland, but chiefly in the Eastern Provinces, salt is also obtained from brine wells and from scrapings of surface soil. In Ubon and Udawn Provinces there are many localities where the surface soil is very rich in salt.

The average annual export of salt from Siam in the five years ending March 31st 1930 has been 757,081 piculs (45,424,860 kilos), valued at Tcs. 751,605.

There are, of course, many other industries, some of which are of considerable local importance, but considerations of space forbid their mention here.

Salt-pans at Tachin.

Salt collected from salt-pans, Tachin.

CHAPTER XVI

CO-OPERATIVE MOVEMENT

Introduction

Since Siam was opened up to foreign trade in the middle of the last century, there has been a marked change in the economic conditions of the country. Instead of producing enough rice for her own internal needs, as she was merely called upon to do before 1850, Siam now produces and exports a large surplus, amounting on an average to a million tons a year, and has thereby created a financial asset of great value to the country. One may say, indeed, without fear of contradiction, that it is primarily this fact which has enabled Siam to carry out her various schemes of development, such as railway and irrigation projects.

For an example of the contrast between the old and new style of life in Siam, we may well compare the present conditions obtaining in Lomsak and Ayudhyā.

In Lomsak the rice grown is produced purely for local needs and is still in many cases probably used as an article of barter. But little capital is required and the population, though self-contained, is unprogressive.

But now in the Southern Central Provinces a large surplus of rice is grown for export. This requires more land under cultiva-

tion, and this in turn requires working capital: the undertaking has in fact been put on a commercial basis. The peasant, however, has no capital of his own, and as there is no organised credit institution to which he can turn, there steps in the private money-lender, who appears at first in the guise of a friend, and who offers him the necessary money, but on terms which in the long run leave him practically no margin of profit—terms which, indeed, involve the peasant as a rule more and more deeply in debt.

It may be safely said that at the present day the peasant cultivators, in those parts of Siam where rice is grown for commercial purposes, are as a class heavily in debt to private money-lenders: and the moral consequences of this indebtedness are of a disastrous nature, for the peasants are not only losing proprietorship of their land, but in addition all initiative and desire to improve their lot.

The reasons why the borrowing of money from private money-lenders affords no prospect of advancement is that the money-lender is usually lending out money on indifferent or poor security to the individual cultivator, and therefore has to charge a high rate of interest as insurance against loss; whereas an organized credit institution, such as a Bank, will only lend money on good security and can therefore rest content with a moderate rate of interest.

The Government recognized the necessity of finding, as remedy for this state of things, a means by which the peasant cultivators could provide a security good enough to commend itself to an organised credit institution, and determined to introduce the Co-operative Credit Movement, a system which, in addition to being a remedy for material ills, possesses an almost incalculable moral and educational element.

Since the inauguration of the movement, several progress reports have appeared in "The Record"* and it is from these reports that the most of the following information has been taken.

* The Official Organ of the Board of Commercial Development issued quarterly by the Ministry of Commerce and Communications, see Chapter XXII.

The principle underlying the movement is for an isolated community of people to combine and to bring to that union a mutual responsibility which serves as a basis for security, and widens their range of credit to an extent which, individually members of that union cannot approach. Acting thus in a collective manner, this union or society of villagers can then apply to an outside agency, such as a Bank, and obtain advances at a moderate rate of interest for the purpose, inter alia, 1) of paying debts, 2) buying land and 3) purchasing agricultural implements.

Thus, instead of each individual having to go to the nearest money-lender to borrow money for his wants at an extortionate rate of interest, the group of individuals is in a position to bargain with an outside agency as to the terms and rates of interest on which it wishes to borrow money.

It should be further explained that, as all the members of a society are to be responsible jointly and severally for one another, they must be very careful of the individuals whom they admit to be members of their society. This point involves the following conditions:—

a) The members must all live in the same village;
b) They must all know one another well;
c) They must be persons of good reputation, and not easily given to quarrelling;
d) Some at least must be able to read and write; for the purpose of acting on the Committee and keeping the Society's accounts.

Financial Aspect of Movement

The problem of financing the beginnings of the movement was solved by an arrangement with the Siam Commercial Bank in B. E. 2459 (1916), by which the latter undertook to advance up to 300,000 Baht, this sum being the limit sanctioned and guaranteed by the Ministry of Finance. The Registrar of Co-operative Societies was empowered to establish and register Societies, and to authorize the borrowing of loans within the limit mentioned above.

The question then arose, under the limitation specified, how best to utilise the money at the disposal of the Registrar.

At first the movement was intended in the light of an experiment, and the Government decided to start the type of rural credit society which it thought was best adapted to the conditions of the country. It was ultimately decided to employ part of the money in assisting a group of villages in the Lopburi district, which is thickly populated, and where the cultivation of rice is being commercially developed to an ever increasing extent, and where the farmer is systematically exploited by the money-lender; and the other part in providing capital to a group of villages in the Pitsanulok district, which is sparsely populated and where the people, who are poor, have but lately migrated from the south. The idea in this latter case was to use the organisation thus formed as a basis for future colonisation, as vacant land is plentiful and the cost of clearing it does not require a large amount of capital.

Up to end of the year B. E. 2470 (March 31st 1928) the financing of the Movement by the Siam Commercial Bank was still confined within the limit of the 300,000 Baht originally sanctioned and guaranteed by the Ministry of Finance. At the beginning of the year B. E. 2471 an additional cash credit of 200,000 Baht from the Siam Commercial Bank was granted, thus bringing the total working capital placed at the disposal of the Registrar for the further extension of the movement to 500,000 Baht. This year the Special Law on Co-operative Societies had been promulgated as "The Co-operative Societies Act B. E. 2471." At the beginning of the year B. E. 2472 (1929) the Government granted further facilities by giving its guarantee to the Siam Commercial Bank for a loan of 500,000 Baht, thus bringing the total working capital at the disposal of the Registrar up to 1,000,000 Baht.

Legal Aspect of Movement

As the amount of Capital at the disposal of the Societies was small at the first start, and the movement was merely intended in the light of an experiment, no Special Law was enacted, but the legal requirements of the scheme were met by an amendment to

the Law of Associations, passed in B. E. 2459 (1916). From this amendment the Societies drew their legal status, and the Registrar his authority in administering them.

The Special Law on Co-operative Societies has been promulgated as "The Co-operative Societies Act, B. E. 2471" and came into force on the 19th. May, B. E. 2471 (1928).

The new Act, being a Special Enactment for the administration of the Co-operative Movement alone, gives a wide scope of activity in the field of Co-operation.

Administration of Movement

The Registrar is the official responsible for the administration of the Co-operative Societies, and his duty is to register societies, supervise their operations and audit their accounts annually. In these duties he is assisted by a number of Inspectors who visit the societies at regular intervals and make reports on them to the Registrar. It must not be thought, however, that these inspectors visit the societies purely in their capacity as officials. Special care is used in their choice, and it is enjoined upon them to avoid as much as possible the rôle of "Official" and to appear in that of "Friend". The underlying idea is to make the members understand that the money which they are using does not belong to the Government, but is their very own; and to try and inculcate into them a spirit of hopefulness, and the habit of thrift and self-help.

Formation of a Society

The membership of a society is limited to a maximum of 50 and a minimum of 10. On the formation of a society, a general meeting of prospective members is held, and after the number and personnel of the members have been agreed upon, a Committee of six is elected from among them, comprising a Chairman, Treasurer, Secretary and three members of Committee.

Each member is required to put in a statement of his assets and also of his liabilities, and of the amount of loan for which he wishes to apply to the Society, in order to meet his requirements. The purposes to which the loan will be put must be clearly stated, and will be embodied ultimately in his contract.

In deciding upon the amount of each individual loan, the Society will be guided by the needs of the member in question, and by the income likely to be earned by him as a result of the loan made. The personal character of the member is implied by his admission as a member of the Society.

Having decided upon the amount to be loaned to each individual, the Society then passes a resolution fixing the amount of the total loan to be borrowed from the Bank for the use of the Society during the year in question. This amount is usually slightly in excess of the aggregate amount of the individual loans.

The Society then applies to the Registrar for sanction to borrow this sum, and in granting or withholding his sanction, the Registrar will be guided to a large extent by the value placed by the Inspectors upon the aggregate amount of land held by the Society's members. In no case does the amount sanctioned exceed 50% of the total value of that land, which is rated at a very conservative estimate.

The money is at present borrowed by the Society from the Siam Commercial Bank at 6% (compounded quarterly) and, when obtained, is lent out to the members at the rate of 12% per annum. This gives the Society an actual profit on the interest charged of nearly 6%.

Reserve Fund

The profit thus gained goes to form the reserve fund of the Society which is built up for the following purposes :—

1. To meet any deficit which may arise in the case of eventual liquidation.

2. Ultimately to form the working capital of the Society, when all the loans of the Society have been paid back to the Bank.

3. Generally to strengthen the credit of the Society.

As the responsibility of the members is mutual and joint, all will be careful to see that each loan is used for the purpose for which it is granted, as stated in the contract, and also that the members repay their loans to the best of their ability.

At the close of each year the accounts of the Society are made up by the Committee, and audited by an official appointed by the Registrar, who will also examine their cash books, minute books, and all other papers belonging to the Society, to see that proper meetings have been duly held and that the affairs of the Society are in good order.

Classification

The system of classification of societies was put into practice among the societies in Siam in the year B. E. 2466 (1923), and has been found to be useful, as it has provided a source of friendly competition and has helped the societies to take a deeper interest in their own progress with a view to keeping pace with their neighbours near by. The societies are divided according to their quality into 4 classes, namely 1st, 2nd, 3rd, and 4th. New societies are not classed. The basis of classification is as follows:

1. Co-operative Spirit
2. Administration
3. Repayment of loan
4. The keeping of books and accounts.

Deposits received by Societies

During the last few years (since the year B. E. 2467, or 1924) the societies of the 2nd class rank have been allowed to receive deposits from the outside public. It was decided that only those societies, which had reached the second class and could be considered on a firm and safe footing, should be allowed to receive such deposits, which are not guaranteed by the Government.

This idea was to create public confidence in the movement, and enabled the societies to increase their working capital and to place more money at the disposal of their members for augmenting cultivation.

Review of the Movement

The movement was inaugurated in the year B. E. 2459 (1916), and the Wat Chan Society, situated in Pitsanulok, was formed as the first society.

This was the only society formed during that year. But in subsequent year many societies were started in Pitsanulok and

Lopburi as occasion offered, and at the end of B. E. 2468 (1926) the number of such societies reached 77, with a membership of 1,414, and a working capital of 261,165.97 Baht, borrowed from the Siam Commercial Bank.

The progress of the movement may appear rather slow, as only 77 societies had been formed in ten years. It is, however, still in the experimental stage, and working within a very narrow limit of capital.

Whenever the amount of borrowed capital approaches the limit laid down by Government, the formation of new societies has to stop till sufficient capital has been accumulated from the repayment of the loans made to older societies. It will be seen, therefore, that the extension of the movement depends chiefly on the amount of capital available.

In B. E. 2463 (1921), after 60 societies had been established it was found the fund was so exhausted that the establishment of new societies had to be abandoned until B. E. 2466 (1924), when sufficient became available for the purpose.

In B. E. 2466 (1924), the movement lost one society by voluntary dissolution, but this was more than compensated for by the addition of five more societies in that year. In B. E. 2467 (1924), five new societies were formed, and in B. E. 2468 (1925) eight more.

Within the last three years the societies have refunded the greater part of their loan from the Bank. It is mainly owing to this that the establishment of eighteen new societies, in that period, has been possible.

The great flood of B. E. 2460 (1917) and the drought of B. E. 2462 (1919) did much damage to the crops. Had it not been for these disasters, much more of the loan would have been repaid to the Bank and many more new societies would have been formed.

Though in the year B. E. 2469 (1926-1927) no progress had been made in forming new societies, the year had been a noteworthy one by reason of the visit which His Majesty the King paid to the Co-operative Societies at Pitsanulok during His tour of the North of Siam in January 2469 (1927). His Majesty was

graciously pleased to meet the members of the Ban Don Co-operative Credit Society, as well as delegates from twenty-four other co-operative societies in the district of Pitsanulok, and carefully examined all the books, accounts and papers regarding the management of the first-named society. His Majesty showed a lively interest in the working of the Co-operative Movement and, at the close of the proceedings, made a brief address to the group representing the societies of the district.

His Majesty's Address to the Delegates of the Co-operative Society in the District of Pitsanuloke, January 7th 1927.

(Translation)

"It gives Me genuine pleasure to meet you all, as members "of the Co-operative Credit Societies in this District.

"The Co-operative Movement is one of much importance "because it tends to add to the prosperity of My people as a "whole, and, in addition, it teaches mutual help among the mem-"bers in bringing them to work together as a society. It is obvious "that one man working alone will not as a rule be as successful as "a number of men working in conjunction, since the mutual "help given implies common thought and common labour. More-"over, in planning measures, an individual may make a mistake "through ignorance. When many minds apply themselves together, "such mistakes may be avoided and a much better result is assured. "From our meeting to-day I see clearly that you have a good un-"derstanding of the fundamental principles of Co-operation, and a "correct grasp of the importance of the methods which it employs "for assuring to you a firmer position on the land. You all realise "now that, where each individual thinks and acts separately, the "result is not likely to be good, but where many plan and act in "co-operation, increased wealth can easily be obtained. And, "apart from that, such co-operation leads to mutual protection, "since, when your property, such as cattle, is stolen, you can with "good effect help one another to recover it."

"I would urge upon each of you:—Do not think only of

"yourself and your own advantage. Think of the advantage of "your Association, and help one another always."

"In conclusion, I pray for a blessing on all of you. In what-"ever way you earn your living, may you be prosperous and "enjoy good health."

In addition to the above address, His Majesty was graciously pleased to write a personal note in the Inspection Book of the Ban Don Co-operative Credit Society, of which a translation is given below:—

(TRANSLATION).

"The visit which I have for the first time paid to-day to "this meeting of the Ban Don Co-operative Society has made me "fully realise the value of the Co-operative Movement and its "growth. It is undoubtedly of great help in enabling the people "to earn their living with much better results. The great educative "value of Co-operation lies in the fact that it leads people to use "their minds in common in their work for a living and that it "gives an opportunity for the development of an un-selfish spirit. "Its success will depend on the loyalty of each one of the "members to his Society. For this reason the Co-operative "Movement is one sure means of bringing prosperity to Siam, and "of improving its economic condition, by adding to the wealth of "the members and by promoting cordial friendship in the com-"munity. It is certainly one of the most important undertakings "that the Government has introduced into Siam.

"In this meeting I feel that the members of the Ban Don "Co-operative Society have a good understanding of the meaning "of Co-operation and of its business methods for raising their "standard of living."

PRAJADHIPOK R.

In B. E. 2470 (1927-28) the establishment of four new societies had been made possible by reason of substantial repayments by the older societies. The number of registered societies

at that date was 81, with a membership of 1,491.

In B. E. 2471 (1928-1929) the Special Law on Co-operative Societies had been promulgated as "The Co-operative Societies Act B. E. 2471." At the beginning of the same year an additional cash credit of 200,000 Baht from the Siam Commercial Bank was sanctioned. The additional working capital has been utilized for forming 10 new societies in those districts, where the societies were already established, for there was a large number of cultivators in Lopburi and Pitsanulok, who were in need of co-operative credit as a means of improving their economic conditions.

At the beginning of B. E. 2472 (1929-30) Inspectors of the Co-operative Societies were sent to certain other districts to make an inquiry into their economic conditions and rural life. A few months later an additional cash credit of 500,000 Baht from the Siam Commercial Bank was granted, thus bringing the total at the disposal of the Registrar for the further extension of the movement to 1,000,000 Baht in all. During the year 37 new societies were established, thus bringing the number of societies at the end of the year to 128 with a membership of 2,220. This is the highest figure that has so far been recorded.

During the fourteen years of its existence, the movement has not been idle, and it is a matter of congratulation that such progress has been made in spite of the limitations imposed. The Government fully recognizes the value of Co-operation and its growth and it is to be expected that a number of new societies will gradually be formed to meet the requirement of the cultivators.

The following table will show the financial position of the co-operative societies at the end of the year B. E. 2471 (March 31st 1929).

TABLE I.

ABSTRACT OF THE BALANCE SHEETS OF THE CO-OPERATIVE SOCIETIES AT THE END OF THE YEAR B. E. 2471.

Province	No. of Societies	No. of Members	LIABILITIES											
			LOAN FROM BANK						DEPOSITS					
			Principal		Interest Payable		Total		Principal		Interest Payable		Total	
			Baht	Stg.	Baht	Stg.	Baht	Stg.	Baht	Stg.	Baht	Stg.	Baht	Stg.
Pitsanulok	30	569	83,016	54	14	76	83,031	30	—	—	—	—	—	—
Lopburi	59	1,030	309,927	46	1,124	95	311,052	41	972	40	4	05	976	45
Ayudhya	2	30	7,377	30	443	50	7,820	80	—	—	—	—	—	—
Total ..	91	1,629	400,321	30	1,583	21	401,904	51	972	40	4	05	976	45

LIABILITIES							ASSETS									
RESERVE ACCOUNT						Grand Total	LOANS TO MEMBERS						Land Value		Cash in hand		Grand Total	
At the beginning of the year		Profit during the year		Total			Principal		Interest Payable		Total							
Baht	Stg.	Baht	Stg.	Baht	Stg.	Baht Stg.	Baht	Stg.	Baht	Stg.	Baht	Stg.	Baht	Stg.	Baht	Stg.	Baht	Stg.
46,546	16	8,385	70	45,931	86	137,963 16	121,927	99	13,214	23	135,142	22	219	—	2,529	45	137,963	16
													* 28	41	@ 22	38		
															† 21	70		
147,391	01	27,496	95	174,887	96	486,916 82	441,264	77	37,783	06	479,047	83	3,874	72	2,276	39	486,916	82
													* 393	81	† 1,324	07		
7,271	35	1,124	77	8,396	12	16,216 92	13,307	63	2,884	76	16,192	39	—	—	24	53	16,216	92
201,208	52	37,007	42	238,215	29	641,096 90	576,500	39	53,882	05	630,382	44	4,093	72	4,830	37	641,096	90
													* 422	22	@ 22	38		
															† 1,345	77		

* Amount of Rent due by Members. @ Cash in Government Savings Bank. † Credit Balance at Siam Commercial Bank.

CHAPTER XVII

FOREIGN TRADE AND COMMERCE

In the olden times, of which we have any record, the foreign trade of Siam was almost entirely in the hands of the King, who appointed a special Minister to deal with the foreign merchants—Dutch, English, Moors and others—that came to trade with Siam: and many complaints and difficulties arose out of the dealings of the Ministers appointed in this respect. But with the coming of the reign of King Mongkut and the signing of Treaties with Foreign Powers, especially the Bowring Treaty with Great Britain in 1855, this monopoly of the King's gradually fell into disuse, and in course of time the sole prerogative that he came to exercise was to establish a Department of Customs to collect all duties imposed on the import and export of merchandise. Freedom of trade soon became general, and in the course of the last fifty years Siam has gradually built up a considerable volume of foreign trade, amounting in the aggregate at the present time to about £39,000,000 annually.

The Siamese themselves, however, have up to the present found trading a matter of but little interest. The peasants have

been cultivators, and the upper classes officials, so that the foreign trade and commerce (and much of the internal trade as well) has passed into the hands of foreigners, especially the Chinese. The climate and the almost arcadian conditions of existence have, of course, been mainly responsible for this attitude on the part of the Siamese, in addition to the almost universal contempt for trade shown by the upper classes of any country, when first introduced to it; while the crowds of energetic Chinamen, who flock to Siam yearly to escape from the grinding poverty and over-populated regions of their own country, have been only too glad to find a land where work is to be had, and good profits can be made.

But a change is beginning to take place in the conditions of life in Siam. The Government service cannot go on absorbing the educated classes to an unlimited degree, and it will very soon be necessary for the latter to realise that their sons at least will have to learn how to earn their own living.

In the meantime the Chinese own and work the rice-mills; the saw-mills are mostly in European hands; while the import and export trade is also almost entirely conducted by Chinese, European, and Indian firms and merchants. The trade with Europe is practically entirely in European hands, British firms predominating; and it is reckoned that about 70% of the foreign trade of the country is with the British Empire.

The movements of the foreign trade of the Kingdom, as a whole, have only been recorded since the year B. E. 2463 (1920-21), all previous records have referred to the Port of Bangkok only. By far the greater portion of the trade of the Kingdom, about 85% to 90%, passes through the Port of Bangkok. The main exception is tin, which is exported exclusively from the Southern Provinces.

There are no records for the trans-frontier trade, except that which goes by rail between Siam and the Federated Malay States. The trans-frontier trade with Burma and French Indo-China is largely concerned with foreign goods imported by the Port of Bangkok.

For an agricultural country such as Siam is, without any capital invested abroad, or performing any services, such as shipping or insurance, it is essential that the balance of trade should be on the right side, and that exports should show a substantial annual excess over imports. In view of the fact that Siam has, so to speak, "all her eggs in one basket", namely Rice, it is not an easy task to guarantee a maintenance of this condition, and the effects of one bad rice-crop like that of 1919 are apt to be of a disastrous nature, as some of the following figures will show.

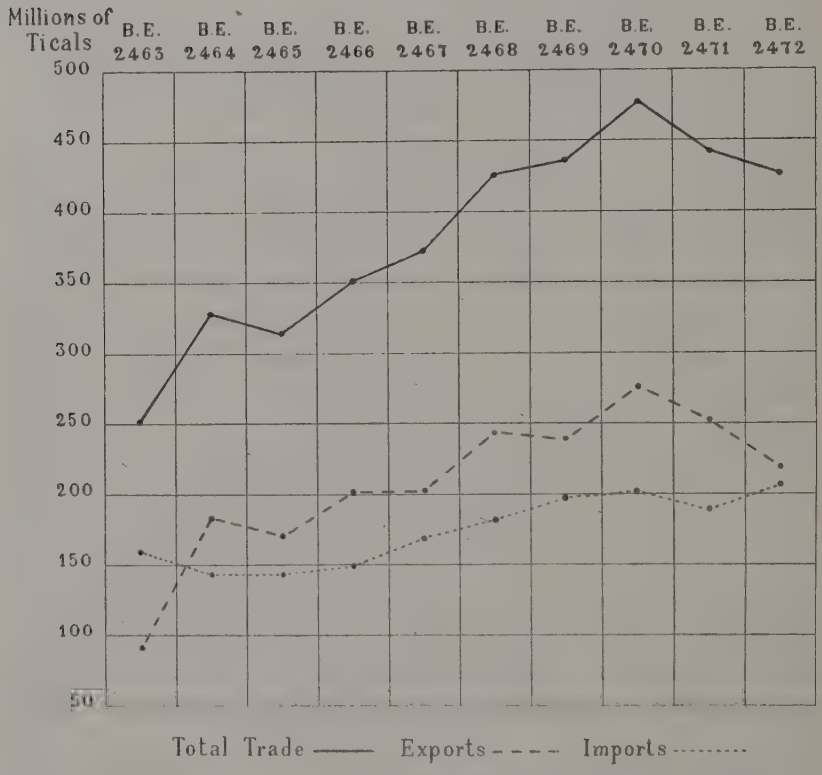
In studying the figures which follow it should be borne in mind, however, that the balance of trade does not present quite an accurate picture of the prosperity of the Kingdom; for the actual values of the exports of different commodities do not all bear the same relation to the country's welfare. In the case of rice, for instance, most of the labour and capital of the industry are indigenous, so most of the profits remain in the country. On the other hand, in such industries as teak and tin a great deal of the capital is held by foreigners and much of the profit goes out of the country, and, particularly in the case of tin, the labour is largely foreign and a considerable proportion of its savings go abroad. This must not be taken to mean, however, that the last mentioned industries are not a great asset to the country, as they undoubtedly are.

The total trade of the Kingdom for the ten year period B. E. 2463 to B. E. 2472 (1920-21 to 1929-30) is shown on the following graph. The first year of that period, B. E. 2463, showed a deficit in exports, amounting to Tcs. 69,000,000, instead of a balance. This was owing to the failure of a large part of the rice crop in B. E. 2462 (1919-20), and the consequent prohibition of the export of rice for a period. Since then the balance of trade has kept well on the right side, with a substantial excess of exports over imports, till the last year of the series B. E. 2472 (1929-30), when the balance in favour of exports was again much reduced owing to a poor rice crop in the previous season.

TRADE OF THE KINGDOM OF SIAM

for the ten years

B.E. 2463 to 2472 (1920-21 to 1929-30)



During the five years B. E. 2463 to B. E. 2467 (1920-21 to 1924-25) the aggregate value of the exports amounted to Tcs. 849,204,150 and that of the imports to Tcs. 767,699,587, leaving a balance in favour of exports of Tcs. 81,504,563, or an annual average of Tcs. 16,300,912, this low average being due to the adverse balance of trade in B. E. 2463, alluded to above. The aggregate values for the last five years, B. E. 2468 to B. E. 2472 (1925-26 to 1929-30) show a considerable increase, that for exports amounting to Tcs. 1,232,514,275 and that for imports to Tcs. 975,481,619, giving a balance in favour of exports of Tcs. 257,032,656, or an annual average of Tcs. 51,406,464.

For comparison with the above figures the returns for the five years B. E. 2453 to 2457 (1910-11 to 1914-15), practically the

pre-war period, may be given; but it must be remembered that they refer to the Port of Bangkok only, so some 10% to 15% must be added to make them really comparable with the statistics of the past ten years. During those five years, then, the aggregate value of the exports from the Port of Bangkok amounted to Tcs. 493,000,000, and that of imports to Tcs. 387,000,000, leaving a balance in favour of exports of Tcs. 106,000,000, or an annual average of 21.2 million Ticals. After making an ample allowance for the trade of other ports, it will be seen that the commerce of the Kingdom has made great strides since the pre-war period.

Exports

For the past five years ending March 31st 1930, the average annual value, in millions of ticals, of the principal articles exported has been as follows:—

1.	Rice	169.60	7.	Swine	2.52
2.	Tin Ore	22.06	8.	Other Woods	2.40
3.	Teak	9.25	9.	Copra	2.23
4.	Rubber	5.53	10.	Hides	1.72
5.	Salt Fish	3.48	11.	Bullocks	1.43
6.	Sticklac	3.00	12.	Poultry	1.12

Many of these articles have been dealt with in preceding chapters, so they will not be further considered here.

During the year B. E. 2472 (1929-30), the principal ports and countries to which goods were exported, together with the value of the exports, in millions of ticals, was as follows:—

1.	Singapore	82.34	10.	China	2.85
2.	Hongkong	36.84	11.	Germany	2.55
3.	Penang	33.05	12.	Netherlands	1.69
4.	Japan	15.93	13.	Belgium	1.46
5.	West Indies (other than British)	10.89	14.	Union of South Africa	1.37
6.	Netherlands India	10.48	15.	India	1.18
7.	British Malay States	6.25	16.	Ceylon	1.17
8.	Denmark	3.37	17.	Indo-China	1.14
9.	United Kingdom	3.29			

Imports

The average annual value of the principal imports, for the five years ending March 31st 1930, was, in millions of ticals, as follows:—

1.	Cotton Manufactures	27.35	20.	Caoutchouc Manufactures	2.00
2.	Metal Manufactures	13.22	21.	Flour	1.90
3.	Treasure	11.94	22.	Matches	1.85
4.	Mineral Oils	11.06	23.	Other Fish	1.77
5.	Machinery	9.07	24.	Oil	1.72
6.	Tobacco	8.75	25.	Rattan, Bamboo & Straw Manufactures	1.61
7.	Gunny Bags	8.50	26.	China and Earthenware	1.57
8.	Sugar	7.14	27.	Tea	1.43
9.	Yarn	6.78	28.	Goldsmiths and Silversmiths work	1.42
10.	Vehicles	5.74	29.	Fresh Vegetables	1.34
11.	Silk Manufactures	5.67	30.	Tools, other than Machine	1.20
12.	Opium	5.46	31.	Spices and Condiments	1.17
13.	Beer, Wine and Spirits	3.33	32.	Fruit (not tinned or bottled)	1.11
14.	Electrical Goods	2.70	33.	Cordage and Cables	1.03
15.	Dried Vegetables	2.67	34.	Canned Fish	1.01
16.	Milk, canned	2.66			
17.	Paper	2.57			
18.	Foodstuffs	2.48			
19.	Precious Stones (unset)	2.36			

Cotton Manufactures. These goods are chiefly of Manchester origin, but Japan and the Netherlands are serious competitors. In the past five years there has not been much increase in this import.

Metal Manufactures. Those of iron and steel are naturally the most important. Among some of the larger items may be mentioned bars and sections to the value of over a million ticals, chiefly supplied by, in order of value, the United Kingdom, Belgium, Germany and France. Galvanized sheets were imported to the value of over four millions ticals last year; Japan supplying about three million and the United Kingdom one million. Enamelled goods account for over one million ticals, the bulk coming from Japan. There has been some increase in the import during the past five years, from 11.19 millions in the first year to 14.87 millions in the last.

Treasure. The most important item under this heading is gold leaf, which comes almost entirely from Hongkong. The import shows a drop of from 8.94 millions of ticals in the first year of the five to 3.57 millions in the last.

Mineral Oils. Kerosene is the largest import among these, but benzine is approaching it. They both show an increasing import, most marked in the case of benzine. Netherlands India supplies the bulk of both.

Tobacco. This heading includes all forms of manufactured tobacco, about 90% being in the form of cigarettes. This import is now more or less stationary.

Gunny Bags. These are intimately connected with the rice trade, and come chiefly from India. The import has shown some decline in the past five years.

Sugar. Netherlands India supplies about 80% of the sugar imported. The import fluctuates but little.

Yarn. The principal items under this head are white and grey cotton yarn and artificial silk. Most of the white cotton yarn comes from Hongkong, while the bulk of the grey cotton yarn and artificial silk are supplied by India and Italy respectively.

Vehicles. Motor-cars and parts account for nearly three-fifths of this import; while railway cars and trucks are also a big item. The United States of America takes the lead in supplying motor-cars, while the United Kingdom does the same with regard to railway cars and trucks, Belgium coming second.

Silk Manufactures. Silk piece goods are the chief item in this trade, over three-fifths coming from Hongkong; part, on doubt transhipped from Japan, which also supplies a good deal direct.

Opium. This is now imported only by the Government, chiefly from India.

Beer, Wine and Spirits. Brandy and samshoo together account for nearly two-thirds of this import. The brandy comes chiefly from France and the samshoo from China and Hongkong.

Electrical Goods and Apparatus. This import has shown a marked increase, from a value of Tcs. 926,506 in the first year of the series to Tcs. 4,648,180 in the last. The United States of America takes the lead in this trade, with Germany a close second, the United Kingdom being third.

Dried and Fresh Vegetables. Hongkong and China supply the bulk of both of these. The import fluctuates, but on the whole does not seem to be increasing.

Milk, Canned. This import has greatly increased in the last ten years. In B. E. 2463 (1920-21) the import was valued at Tcs. 621,793, in B.E. 2472 (1929-30) it was valued at Tcs. 3,153,829. The Netherlands head the list of suppliers, with Switzerland next.

Paper. This includes both unprinted paper and books, as well as paper manufactures. About half consists of unprinted paper, most of which is supplied by Germany and Norway.

Foodstuffs. The largest item under this heading is Cereals the import of which comes to nearly two million ticals yearly. Rice, imported from Burma for the mining population on the West coast of the Peninsula, accounts for four-fifths of the import of cereals. Biscuits, coming chiefly from the United Kingdom, are another large item.

Precious Stones (unset). Belgium supplies the bulk of these. There has been some falling off in this import in recent years.

Caoutchouc Manufactures. Motor-car and cycle tyres now account for a great part of this import, which has increased from 1.3 to 2.5 millions of ticals in the past five years.

Customs Tariffs

On March 27th 1927 a new Tariff became operative. With the exception of rice, all duties on exports were abolished—the Royalties on teak and tin remaining unaffected. The general import duty of 3% *ad valorem* was increased to 5% *ad valorem*, except for a small free-list, and for a few articles selected for specific rates of duty. The import on spirituous liquors was also increased. Later an amendment increased the duty on certain articles.

The more important import duties are now as follows:—

Beer and Wine	ad valorem 12 per cent.
Spirituous Liquors	Ticals 2.50 per litre of absolute alcohol.
Kerosene	Stgs. 10 per gallon of 4.546 litres.
Benzine	Stgs. 20 per gallon of 4.546 litres.

Matches	Stgs.	30 per 100 boxes.
Sugar, including Glucose	Stgs.	3 per Kgm.
Cinema Films	Stgs.	30 per length of 30.48 metres (100 linear feet).
Cigarettes	ad valorem	25 per cent.
Motor Cars and Parts	ad valorem	10 per cent.
Other Articles	ad valorem	5 per cent.

Import Prohibitions. These include Opium, Arms, Ammunition and Explosives (except under license), Harmful Habit-forming Drugs and Skimmed Milk.

There are a number of articles exempted from duty, among them being Samples of Merchandise, Books and Periodicals, Quinine, Serums and Vaccines, and Treasure and Gold leaf.

Export duties are levied only on rice in various forms, and vary from 9.4 satangs per picul on Cargo Meal to 18.4 satangs per picul on Cargo Rice.

The export of certain articles is prohibited, among others: Opium, Siamese Silver Coins, Harmful Habit-forming Drugs and Archæological and Artistic Objects (except under license).

Shipping

The chief port of Siam is, as already mentioned, that of Bangkok, which is situated 22 miles from the mouth of the Menam Chao Phya.

Large vessels of deep draught, that cannot come up to Bangkok, anchor at Kaw Sichang, an island in the Gulf about 19 miles from the bar, and load and unload by means of lighters; or the unloading may be commenced at Kaw Sichang and finished in Bangkok.

The total number of ships arriving in the Port of Bangkok during the year ending March 31st 1930 was 1,013, with a total tonnage of 1,145,922. These totals include 122 ships with a tonnage of 220,232, which arrived in ballast, but they do not include 286 junks arriving with cargo.

Excluding the junks, these ships flew the flags of ten different nations. The number of ships of each nationality, with their total tonnage was as follows:—

Nationality	Number of Ships	Tonnage
1. Norwegian	390	349,294
2. British	249	334,517
3. Danish	45	105,769
4. Japanese	49	100,225
5. Siamese	194	94,519
6. Dutch	57	74,326
7. American	9	40,673
8. German	4	29,924
9. Swedish	3	8,613
10. French	13	8,062

The principal ports from which ships reported during the year were:—Singapore, 552 ships with a total tonnage of 536,581; Hongkong, 120 ships with a total tonnage of 147,968; Indo-China ports, 163 ships with a total tonnage of 138,372 and China ports, 77 ships with a total tonnage of 106,580.

The principal ports for which they cleared were:—Singapore, 452 ships with a total tonnage of 367,245; Hongkong, 225 ships with a total tonnage of 292,531; Netherlands India, 55 ships with a total tonnage of 94,364; Japan, 40 ships with a total tonnage of 56,979; Indo-China, 127 ships with a total tonnage of 74,976 and Denmark, 17 ships with a total tonnage of 56,979.

This concludes the survey of the Foreign Trade of Siam, and it now only remains to say a few words regarding the economic future of the country.

As far as Central and Upper Siam are concerned, so long as the country remained self-sufficient, in a semi-idyllic, patriarchal state, it did not matter much whether there was a surplus of rice for export or not; but now with the modern march of commerce through the world, and Siam committed to a policy of economic development on western lines—irrigation, roads, railways and the like—adapted of course to suit local needs, and also with the volume of imports increasing year by year, it is a serious matter for the rice-crop to fail, to such an extent as to

leave no exportable surplus.

Everything points, therefore, in one direction. If Siam is to be relieved of anxiety as to her economic future, not only must more land be put under rice cultivation, with the harvest assured as far as possible by irrigation; but she should also do her utmost to find some other staple crop, so that the progress and prosperity of the country may not remain entirely dependent upon one single harvest, over whose fruitfulness neither the Government nor the people have any definite control.

At the same time, from figures given, it is clear that the foreign trade and commerce of Siam on the whole has shown a steady and marked advance: and there seems to be no reason why that steady advance should not continue, given reasonably favourable weather conditions, and a continuation of the happy relations which now exist between Siam and her neighbours, and in fact all those countries of the world interested in her peaceful growth and development.

CHAPTER XVIII

RAILWAYS

General

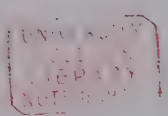
The construction of the Royal State Railways of Siam was started with the Northern or East Bank System in 1892.

Starting from Bangkok on the East Bank of the Menam Chao Phya River, the line runs practically due north to Chiengmai, km. 751. At Ban Dara Junction, km. 458, a branch line of 30 kms. runs west to Sawankaloke. At Ban Phaji, km. 90, the line branches to the north-east through Korat to Ubol, 575 kms. from Bangkok.

From Bangkok a line runs also due east to the Cambodian frontier at Aranya Pradesa, 255 kms. from Bangkok.

When the East Bank System was started, it was decided to adopt 4′ 8½″ gauge, and this gauge was laid as far as Chiengmai and Korat, as well as for the first 60 kms. of the Eastern Line. Some years ago, in view of projected extensions and connections, the question of gauge was carefully considered. Since the 4′ 8½″ gauge had been adopted conditions had radically changed. The Malay States, Burma and Indo-China had all adopted metre gauge in the intervening 30 years; connection between the west bank

Bangkok Station.



system and the Malay States was almost completed, and the Burmese connection was mooted. It was, therefore, decided to convert the whole system to metre gauge and to connect the East and West Bank systems via Rama VI Bridge. This conversion is so far completed that all trains are now running metre gauge.

The west bank lines start from Bangkok Noi, and were opened to traffic as far as Petchaburi, km. 150 from Bangkok Noi, in 1903. In 1909 it was decided to continue the line down the peninsula, to connect ultimately with the Malay States Railways. The first connection was made at Padang Besar on the Perlis frontier, km. 974 from Bangkok Noi. A bi-weekly service of mail trains between Bangkok and Prai, the station for Penang, was put into operation in 1922, the whole journey taking about 31½ hours.

From Haad Yai Junction, km. 929, a line runs due south to connect with the Malay States East Coast System at Sungei Golok, km. 1143; this line was opened in 1922. From Haad Yai also a branch 30 kms. long runs to Singora on the East Coast.

At Kao Choom Tong, km. 781, connection is made to Nakon Sritamaraj; this line is 34 kms. long. At Tung Song, km. 752, a branch 93 kms. long runs to Kan Tang on the West Coast.

The total length of all lines opened to traffic at the end of March 1930 was 2893 kms.

The most important developments of recent years have been the connecting up of the East and West Bank Systems by the Rama VI Bridge and the opening up of the north-eastern extension beyond Korat. A further extension in the north-eastern area from Tanon Chira, km. 266, to Kon Kaen, km. 450, is under construction. Reconnaissance surveys have been made for lines from Kon Kaen to the Indo-China frontier at two points, and the survey proper will shortly be undertaken.

A connection with Burma will be made in due course from Prachuab Kirikan, km. 302, of the west bank line. The whole system is operated as a single track line except for the portion Bangkok to Bangsue on the northern line, a distance of 8 kms. This double track is being extended to Klong Rangsit, km. 28,

and will ultimately be carried on to Ban Phaji Junction, km. 90.

Permanent Way

The track is laid with 50 lb. rails fastened to hard wood sleepers with dog spikes. It is contemplated, however, relaying about 340 kms., including the double line, with rails of 70 lb. B. S. S.

Excellent ballast has been available on all lines, the depth under the sleepers being 15 cms.

For purpose of maintenance the track is divided into districts of 300 kms., each under a Maintenance Engineer, with three Chief Permanent Way Inspectors. These again have Permanent Way Inspectors with districts of 18 kms. Each coolie gang consists of 6 men with a Headman, working 6 kms. of single track.

Rolling Stock

Locomotives and rolling stock are all of most modern design. During the last few years most of the locomotives have been supplied by Baldwins Ltd. of America, and Hanomag of Germany. All these are of the "Pacific" type. Six "Garrat" locomotives are on order in Germany; they will be used for working the heavy goods trains over the main pass between Ban Phaji and Korat on the North-eastern Line.

Two "Diesel" locomotives are employed for shunting work, these are 200 H. P.

Six Diesel electric locomotives have been ordered and will be used on the mail train services and for passenger and goods services round Bangkok. The underlying motive in introducing Diesel electric traction is to save the long haul of firewood required to keep the Bangkok terminus supplied.

Passenger rolling stock is practically all of the bogie type, and includes restaurant cars and night and day coaches. Of recent years all this stock has been supplied by British firms. In some cases complete vehicles are obtained, but as a rule only the underframes and fittings are purchased abroad and the body work is built in the Railway workshops. The last order placed includes 30 all steel bogie coaches, the first of this type to be employed in Siam.

The South Express leaving Bangkok Station.

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All the goods vehicles, both of the 4 wheel and bogie type, are purchased as required by open tender. Latterly European Continental firms have been supplying all requirements.

Telegraph and Signals

The Railways maintain some 7000 kms. of telegraph lines for their own service, and in addition over 8000 kms. are maintained for the Post and Telegraph Department. Long distance telephones are employed to a considerable extent in traffic control, and their use is being extended.

Interlocking is installed at all principal stations. The plant is mostly supplied by the Allgemeine Elektricitats Gesellschaft of Berlin. Tyer's Tablet instruments and Neall's Token instruments are employed in some sections.

Finance and Traffic

The financial year for the system begins on April 1st. The figures for the year ending March 31st 1929 are as follows:—

Gross Receipts	Baht	20,465,102
Working Expenditure	„	8,063,570
Nett Receipts	„	12,401,532
Renovation Fund & Special Reserve	„	1,397,605
Nett Profit	„	11,003,927

The Gross Receipts were made up as follows:—

Coaching	Baht	8,319,696
Goods	„	10,908,179
Live Stock	„	797,639
Miscellaneous	„	439,588

A total of 6,205,500 train kms. was worked at a cost of Baht 1.30 per km.

Organization

The State Railways is a Department of the Ministry of Commerce and Communications. The head of the Department is the Commissioner General, a post at present held by Phya Sarasastra Sirilakshana, A. M. I. C. E., M. Inst. Transport. Directly under the Commissioner General come the Heads of the various services, namely; the Chief of Central Office, the Chief Auditor, the Chief of Technical Office, the Chief Engineer for Ways and

Works, the Chief Mechanical Engineer, the Chief Electrical Engineer, the Traffic Superintendent, the Superintendent of Stores and Hotels, the Legal Controller, and the Chief Highway Engineer.

As far as possible a weekly meeting of all the Heads of Services is held in the Board Room under the Chairmanship of the Commissioner General. At this meeting free discussion takes place on all subjects affecting the Railway Administration and by its means valuable co-ordination between the various services is obtained.

Hotels

Two hotels are maintained by the Department in Bangkok. One, the Phya Thai Palace, is a Royal Palace which, being no longer required by His Majesty, was converted to an Hotel. A high standard of comfort is available here for travellers. A terminal hotel facing on to the main arrival platforms was put into service about two years ago. It is fitted with every modern convenience. The ground floor contains the Entrance Hall, Lounge, Offices, Restaurant, Kitchens, Ladies' and Gentlemen's Lavatories, Post Office, and at the Northern end is the Custom House for dealing with incoming baggage. The upper floor has nine bedrooms and a suite-de-luxe consisting of bedroom, bath room and sitting room. Each bedroom has a private bath room with hot and cold water laid on, and the most modern sanitary appliances. Communication all over the hotel is by automatic telephone, which is also connected to the post-office system, so that visitors can ring up any number in the Bangkok Telephone Directory without leaving their room.

Projected Works

The old layout of the Bangkok Terminal Yard being rather cramped and inconvenient, a new layout with extended platform accomodation will be shortly put in hand.

A marshalling and sorting yard is to be constructed at Bangsue, km. 8 of the Northern Line, from whence the goods trains can be despatched direct to all lines. Work on this yard was started during the financial year beginning April 1st. 1930.

Tourist Interests

Bangkok itself is an extremely interesting city from the tourist's point of view. Permits can be obtained through the Railway Information Bureau, situated at the Bangkok Terminus, to view the Grand Palace, the Temple of the Emerald Buddha, the Throne Hall, and other places. Guides are provided at a moderate charge. Besides the above, the numerous "Wats" or temples are well worth a visit, as is the National Library and the Museum. Trips by launch on the river both by day and after dark are interesting and instructive.

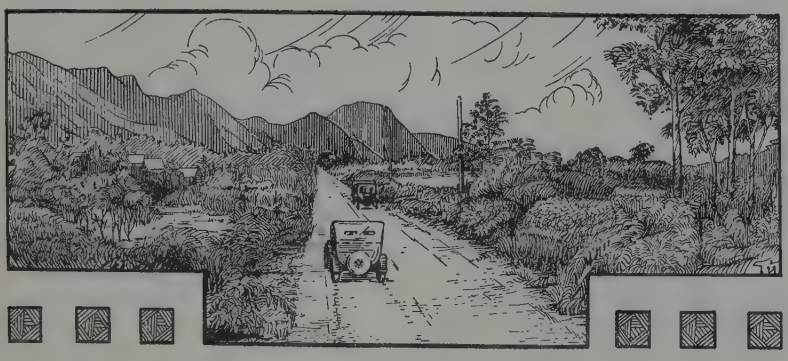
At Ayudhya, km. 72 of the Northern Line, the old capital, are many fine ruins. Chiengmai, the terminus of the Northern Line, is well worth visiting, the scenery on parts of the line being very fine. A comfortable railway hotel is found here. The limestone caves at Petchaburi, km. 150 on the Southern Line, are very interesting.

More modern tastes are catered for by the Railway Hotel at Hua Hin-on-Sea, km. 212 on the Southern Line. The Hotel, situated close to the sea, is extremely comfortable and the cuisine excellent. The Royal Hua Hin Golf Course, 18 holes, one of the finest courses in the East, is available for visitors at a moderate charge. First class sea bathing is obtainable at all states of the tide. Tennis and billiards, are catered for, and some rough shooting is obtainable at nearly all seasons. A pleasant way of visiting Bangkok and seeing something of Siam generally is to leave the mail steamer at Penang and travel to Bangkok by the comfortable International Express. The journey can be conveniently broken at Hua Hin, from which place there are good daily trains to Bangkok. After the Siam visit the traveller can leave by the Eastern Line for the Cambodian Frontier, whence the famous Angkor Wat can be reached by car and the journey continued to Saigon.

Intending travellers are advised to purchase the Guide to Bangkok and Siam, written by an expert and published by the Royal State Railways. It is obtainable from the Information Bureau and at Phya Thai Palace and Rajdhani Hotels. The

fullest information is given concerning local customs and ceremonies as well as about the things to be seen in Bangkok and elsewhere in the country.

There are also some privately owned railways controlled by the Board of Railway Commissioners. These are short distance lines; the most important being the Meklong Line, running from Bangkok to Tachin and Meklong, and the Paknam Line, from Bangkok to Paknam.



CHAPTER XIX

HIGHWAYS

Siam, having for a long time entered upon the path of modern civilisation, willingly welcomes new ideas coming from that civilisation and does not hesitate to put them into practice as soon as their utility has been demonstrated. Such, at least, has been the case with Land Communications.

Highway Development in Siam has arrived at a critical turning point. New methods of transportation, a greater volume of traffic, a greater weight in loads, and vastly increased rapidity in road travel—all these—have brought the Government to an issue: either some very considerable and immediate change in the character of the road, or a serious and increasing handicap in our rivalry with other nations through the strain and expense of an out-worn system.

This country has had five critical moments in the history of her road system:—

1. The moment when bridle paths and cart tracks were superseded by the parochial system of local roads.

2. The moment when the Department of Ways was created within the Ministry of Communications in B. E. 2454 (1911-12).

3. The moment when the Department of Ways was amalgamated with the Department of Royal State Railways, B. E. 2460 (1917-18).

4. The moment when the Law on Organisation of Railways and Highways was promulgated in B. E. 2464 (1921-22).

To-day, the great fifth change is taking place,—the adoption of modern road construction to meet modern methods of transportation.

Before the formation of the Department of Ways, the powers and duties of designing and constructing highways were vested in the Local Authorities, viz:—the Lord-Lieutenants and Local Governors.

In B. E. 2454 (1911-12), the Ministry of Public Works was, by Royal Decree, re-organized and changed into the Ministry of Communications, and the Department of Ways was created within this new Ministry. Three years later, the first Road Commission was appointed to formulate a policy and programme for highways. This brought about uniformity in road administration throughout the Kingdom.

When the Royal State Railway systems, both North and South, were amalgamated in B. E. 2460 (1917-18), the Department of Ways, for economical purposes, was amalgamated to the Department of Royal State Railways; thus making the railways and the highways supplement each other.

The Law on Organization of Railways and Highways was promulgated in B. E. 2464 (1921-22) and Highways were hence definitely divided into two classes, viz:—State Highways and Provincial Highways: the former are to comprise roads of general interest destined afterwards to form portions of trunk roads and the latter are to comprise roads of secondary or local interest, linking up with either to the railways or to the State Highways.

The following table will give a comprehensive idea of the growth in importance of the Department of Ways and the progressive work it has, up to now, rendered to the country and the public in general. It is to be seen that a steady progress has

Northern State Highway No. 3

Suspension bridge, with a span of 80 metres, over the Me Ngao, between Lampang and Chiengrai.

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been made in following the principles and working out a definite programme of highway construction, compatible with the funds placed at the disposal of the Department. Also, in comparison with neighbouring countries, the cost of construction of roads in Siam is relatively cheap, averaging about Baht 16,000 per kilometre.

STATE AND PROVINCIAL HIGHWAYS

B. E.	NORTHERN DIVISION		CENTRAL DIVISION		SOUTHERN DIVISION		TOTAL KM. OF STATE HIGHWAY	ANNUAL EXPENDITURE
	State	Provincial	State	Provincial	State	Provincial		
	Km.	Km.	Km.	Km.	Km.	Km.	Km.	Baht
2461 (1918-19)	380			2,099*	1,121		3,500 †	832,784.37
2462 (1919-20)	380			2,097*	1,090		3,567 †	1,213,072.50
2463 (1920-21)	420			2,095*	1,161		3,676 †	1,470,127.66
2464 (1921-22)	422.5			2,095*	1,170		3,687.5†	1,867,632.98
2465 (1922-23)	413	15.517	181	1,914*	1,177	47.560	1,771	1,991,471.69
2466 (1923-24)	457	23.017	159	24	1,181	47.560	1,797	2,204,929.76
2467 (1924-25)	457	16.182	159	170	1,188	98.175	1,804	2,004,551.07
2468 (1925-26)	549	19.612	159	489.5	1,250	50.515	1,958	2,004,901.90
2469 (1926-27)	625	35.612	159	799.5	1,250	50.515	2,034	2,099,755.72
2470 (1927-28)	649	59.209	159	828.395	1,247	55.988	2,055	2,636,354.22
2471 (1928-29)	770	59.209	296	828.395	1,259	55.988	2,325	3,716,150.00

* Cart tracks † Including Cart tracks.

This is neither the time nor the place to give exhaustive figures and tables showing annual traffic censuses taken on State Highways; suffice it to say that the vehicular traffic has been increasing every year on every highway, and that the cost of transport has been greatly reduced, wherever a net-work of roads has been established, as can be easily seen by the following few figures taken at random from some annual reports on the Administration of the Department of Ways.

Motor Car Traffic

Northern State Highway No. 3. Lampang—Chiengrai.

In B. E. 2469 the number of trips recorded is 81,606 and in

B. E. 2470 this increased to 151,005, showing an increase of 69,399 trips or 85%.

Central State Highway No. 11. Pimun—Chong Mek Pass.

In B. E. 2470 the number of trips recorded is 1,999 and in B. E. 2471 this increased to 3,002, showing an increase of 1,003 trips or 50%.

Southern State Highway No. 11. Songkla—Sadao.

In B. E. 2468 the number of trips recorded is 88,244 and in B. E. 2469 this increased to 253,052, showing an increase of 164,808 trips or 186%.

Cost of Transport

Northern State Highway No. 3.

The cost of transport per ton kilometre in B. E. 2467 was Baht 0.34 and in B.E. 2471 only Baht 0.12. This shows a reduction of 183%.

The reduction in cost of transport is very gratifying to the Government, especially to the Department of Ways to whose hands the welfare of the Highways of Siam is entrusted.

The work of this Department is all the more interesting as it does not draw its strength from the Government alone but from the Nation as a whole.

The growth in volume and weight of vehicular traffic on the highways during the last 12 years has been general and rapid. The public has not been slow to take full advantage of the benefits conferred upon them by the Government in the shape of improved highways. By the increase in the amount of vehicular traffic it is proved that money spent in the construction, improvement, and maintenance of highways is a sure benefit to the Nation in general. Highway work in Siam is thus at one and the same time a means of military defence, an organ of economic development and an instrument of education.

Road roller drawn by an elephant.

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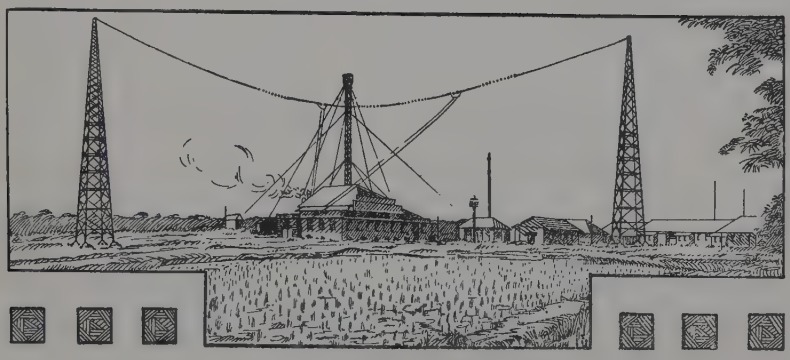

CHAPTER XX

POST AND TELEGRAPHS

Historical

In the old days before Siam had much business intercourse with the outside world, the postal system of the country was based on a very simple organization. The Governor of each town maintained a number of couriers who knew the quickest routes to all the neighbouring cities. Important towns also had special couriers who were well versed in travel to distant cities with which they had business connection. In the Capital the Central Government maintained a large number of couriers to run to all the cities surrounding the metropolis, and a group of special couriers who knew the quickest way to every city in the Kingdom.

The originating office would send its couriers with the letters to the next town on the route in the direction of the point of destination. The other towns on the route would provide couriers to forward the mail to its destination. The routes were well marked and known to all. Resthouses were provided along the routes, which were kept in order by the people. The couriers were treated with great respect, and if they carried the King's letters

special treatment was afforded them on the routes. For urgent and important messages special couriers made the entire trip, and it was the duty of the towns along the route to provide them with fresh ponies and other facilities for reaching their destination.

This system was organized primarily for official messages, but the business interests of the towns also could make use of the service by special arrangement with the couriers. Merchants also had their own couriers and made use of the routes provided by the state.

Before the establishment of the Post and Telegraph Department, foreign mails were transported through arrangements made with the Straits Settlements at Singapore and with the Administration at Hong Kong, through the intermediary of the British Consulate in Bangkok. Ship captains also assisted the traders, by private arrangement to post letters at the next port of call.

This simple system was found inadequate as the internal and foreign business of Siam developed. Foreign communication was uncertain, while inland intercourse was too slow, irregular and inadequate, as no official provision existed for private mails.

In the year 1881 H. M. King Chulalongkorn commanded H. R. H. Prince Bhanurangsi to organize a system of modern postal service, and in the year 1883 the organization was completed. The Post and Telegraph Department was inaugurated with Prince Bhanurangsi as its chief, and with a staff comprised largely of Europeans and other foreigners, until it was possible to train Siamese officials for this specialized work.

The progress that was made was very rapid. Siam joined the Universal Postal Union in 1885. A post-office was established in practically every town in the Kingdom and regular exchange of inland mails were made, the best routes and the quickest means of communication available at the time being utilized.

Attention was also directed to foreign mails and the following chronology of the progress will be of interest:

(1) In 1886 a direct exchange of mail was arranged between Chiengmai in the north of Siam and Rangoon in Burmah by an overland route.

Unloading mail car at Post-office No. 5.

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(2) In the same year direct exchange of mails between Southern Siam and Penang was established through the towns of Puket and Saiburi (Kedah).

(3) In this year direct bags of mail were also exchanged between Bangkok and Brindisi, Naples and Paris to accelerate communication with Europe.

(4) In 1887 a direct exchange of mail between Bangkok and Saigon was established.

(5) In 1890 an exchange of overland mail between the Eastern Provinces and Cambodia was established through the cities of Battambang and Pnompenh.

(6) In the same year the Laos Province of Indo-China was connected to the Northern and Northeastern Provinces of Siam by the exchange of mails between Mukdahan and Savannakhet, Nong Khai and Vientiane, Utaradit and Paklai and between Chiengmai and Banhouei Sai.

The administration speedily established postal facilities between Siam and foreign countries by every means at its disposal. Direct exchanges of mails were put into effect whenever possible, while, when the volume of transactions was small, other foreign offices were utilized as intermediaries to transit the mails. Both Hong Kong and Singapore, two world important shipping centres, were utilized largely as transit offices for mails to various countries of the world.

The inland business was gradually improved to meet public requirements, and with the development of modern means of transportation the Post and Telegraph Department was enabled to speed up communication by taking advantage of all such available means of transport for despatching the mails.

The establishment of the Siam Steam Navigation Company, which operates regular steamers to the various ports on the East and West Coast of the Gulf of Siam, afforded a quicker mail service to and from all the ports on the Gulf of Siam. However, since the opening of the Southern Line in 1917, all the towns on the West Coast of the Gulf have been better served by the railway, leaving only ports on the East Coast to be served by steamers.

The postal service took advantage of all other means of transport facilities available, and thus row-boats were utilized on waterways, bullock carts along cart tracks, and pack animals or carriers where there were only foot paths. Of late years the Kingdom developed other modern means of communication and the postal authorities promptly made use of them, with the result that motor boats have replaced row-boats along the waterways and motor cars replaced bullock carts along the highways. The railways have become the backbone of the postal service, while aeroplanes are utilized to transport mail to inaccessible sections of the country in a few hours, in place of foot carriers or pack animals which used to thread their way over jungle or mountain paths, often requiring weeks to reach their destination. Communication routes and facilities are improving steadily, and the Post and Telegraph Department is ever alert to take advantage of the changing conditions for the benefit of the public.

Bangkok, the capital and metropolis of Siam, is served by 8 regular post-offices and 81 licensed post-offices. Those numbering from 1 to 100 transact every kind of postal business, while those from 101 upwards only do inland business.

Every city in the provinces has a regular post and telegraph office giving almost every kind of service. In the larger towns there are also agents or licensed post-offices, while in every district or Amphur, there will be found a licensed post-office which accepts inland telegrams also, whenever there is telephone connection with the nearest Government post-office for transmission of telegrams.

Most of the railway stations of the Department of the Royal State Railways also transact postal work. Some will accept foreign telegrams and all will transmit inland telegrams.

Thus Siam possesses at present a total of 832 post-offices, of which 118 are regular post-offices, 396 licensed post-offices and 318 railway post-offices. The volume of mail matter dealt with by these offices in a year is approximately 14,000,000 pieces, and is growing steadily.

Licensed Post-office in business district.

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The Telegraphs

The electric telegraph was introduced into Siam by the Ministry of War in theyear 1875 and was originally utilized for official messages only. In that year a line was constructed between Bangkok and Paknam, about 45 km. in length, with a submarine connection to the light-house at the bar. It was mainly used for news of shipping.

In 1878 another line was constructed connecting Bangkok with Bang-Pa-In, up the river from Bangkok, and this was later extended to Ayudhya, the old capital.

The newly founded Post and Telegraph Department entered upon the construction of a telegraph net-work for the Kingdom in earnest. In 1883 the Eastern Line was opened for public service, connecting the capital with Prachinburi, Krabindraburi, Aranya Pradesa, Sisophon and Battambang, and through the Indo-China system with Saigon, which provided an outlet for international telegraph service to the rest of the world.

In the same year the two lines to Paknam and Ayudhya were taken over from the Army and opened for public service under the Department.

In 1884 the Western line from Bangkok to Kanchanaburi and to the Burmese frontier, for connection with Moulmein was completed.

The construction of the inland net was pressed forward, and within 15 years from the introduction of the electric telegraph into the country all the important cities in the Kingdom were linked up by this modern means of communication. Wherever possible the inland system was linked up with those of neighbouring countries at frontier towns, as with Burmah, through Me Sawt in 1898; with the Federated Malay States in 1899, through Songkla and Kedah; and in the same year with Indo-China through Nong Khai.

Considering that the creation of this extensive telegraph system was carried out when there were neither railways nor roads, and with an untrained staff, the work accomplished was very creditable. However, these lines, passing through heavy

jungle in most parts, were very difficult and expensive to maintain. Gradually the telegraph lines were re-located along the railway zones or along the highways, as soon as such routes of communication were built, with the result that these lines are now cheaper to maintain and are more dependable in their operation. This policy is being continued in connection with the present extensive programme of railways and highways development.

The inland telegraph fees, for a considerable time were fixed at one tical for a maximum of 10 words. This rate, in 1929, was reduced to 80 satangs for 10 words and 5 satangs for every additional word over ten, with the result that the traffic has considerably increased from 489,064 in 1926 to a present average business of more than 800,000 inland telegrams a year.

Siam now has 581 telegraph offices including 221 offices at railway stations and 242 offices at licensed post-offices.

The total length of telegraph lines in the Kingdom is now 8,649 km., consisting of 8,597 km. of wire open line; 30 km. of wire underground; 2 km. of underwater cable.

The foreign telegraph service was maintained from the beginning, and through arrangement with the neighbouring countries and the cable companies, three routes were established for telegraphic communication with the outside world. These were the Eastern Line through Saigon, mainly used for service to China, Japan, Indo-China, the Philippine Islands and America; the Peninsular Line through Penang for service to Malaya, Dutch East Indies, Australia, and as alternative routes to India, Europe, Africa, and America; and the Western Line through Moulmein for service to Burmah, India, Europe, Africa and America. Any of these lines could be utilized for telegraph communication with any other office in the world.

Formerly only the ordinary Morse instruments were employed in the service. With the increase of traffic, quadruplex Baudot printing instruments were used for traffic with Indo-China and Wheatstone and Creed printers for service with Malaya. The telegrams are received in printed slips—eliminating errors in re-

ception and decoding, and save considerable time in delivery to the public.

Siam joined the International Telegraph Union in 1885 and has been represented regularly at all the congresses.

The Telephones

The first telephone exchange was established in Bangkok in the year 1886 with 61 subscribers, using the magneto instrument on a single wire system. This installation served satisfactorily until the introduction of electric lights and electric trams into Bangkok. The system was tolerated for 20 years and then abandoned for the present central battery double wire plant.

The growth of the system was rapid, but due to the lack of funds, it was not possible to lay down a comprehensive scheme based on best methods or materials. Under these conditions the growth of the service brought out the weaknesses of the plant, which could only be alleviated but not overcome.

The Government therefore has decided to replace the present system with a complete new underground cable net and modern instruments and equipment. To meet the particular engineering conditions and service problems presented, the underground construction will consist of armoured cables which at street crossings will be laid in steel pipes. The two exchanges will be the last word in modern equipment, and the manual system will be replaced by a complete automatic installation. It is expected to complete the work by 1933, when Bangkok will have as modern a telephone system as can be procured. The salvaged material of the present plant will be utilized, as far as practicable, in the development of telephone service in the provincial towns, which are being supplied with telephones to meet the requirements of their steady business expansion. Several such inland cities have recently been equipped with exchanges, the double wire-magneto-call central battery system being employed. The reliability of the magneto calling and the efficiency of the central battery speaking are combined in this system, which has been developed locally.

The plan of the Administration is to encourage the building

up of small exchanges in inland cities, to extend lines to all the Amphur, or district, offices of the provinces, and later to connect these exchanges by trunk lines, thus working up to the scheme whereby each district can be in telephonic communication with any other in the Kingdom.

At present a simple system of long distance telephone call can be arranged between any two cities, by utilizing the telegraph wires during slack hours in the telegraph service three times daily, as each telegraph office is equipped with a long distance telephone instrument. The postmaster, on request, will arrange for the attendance of both parties at the appointed time.

The telephone service of Siam comprises eighteen exchanges with subscribers and calls as follows:

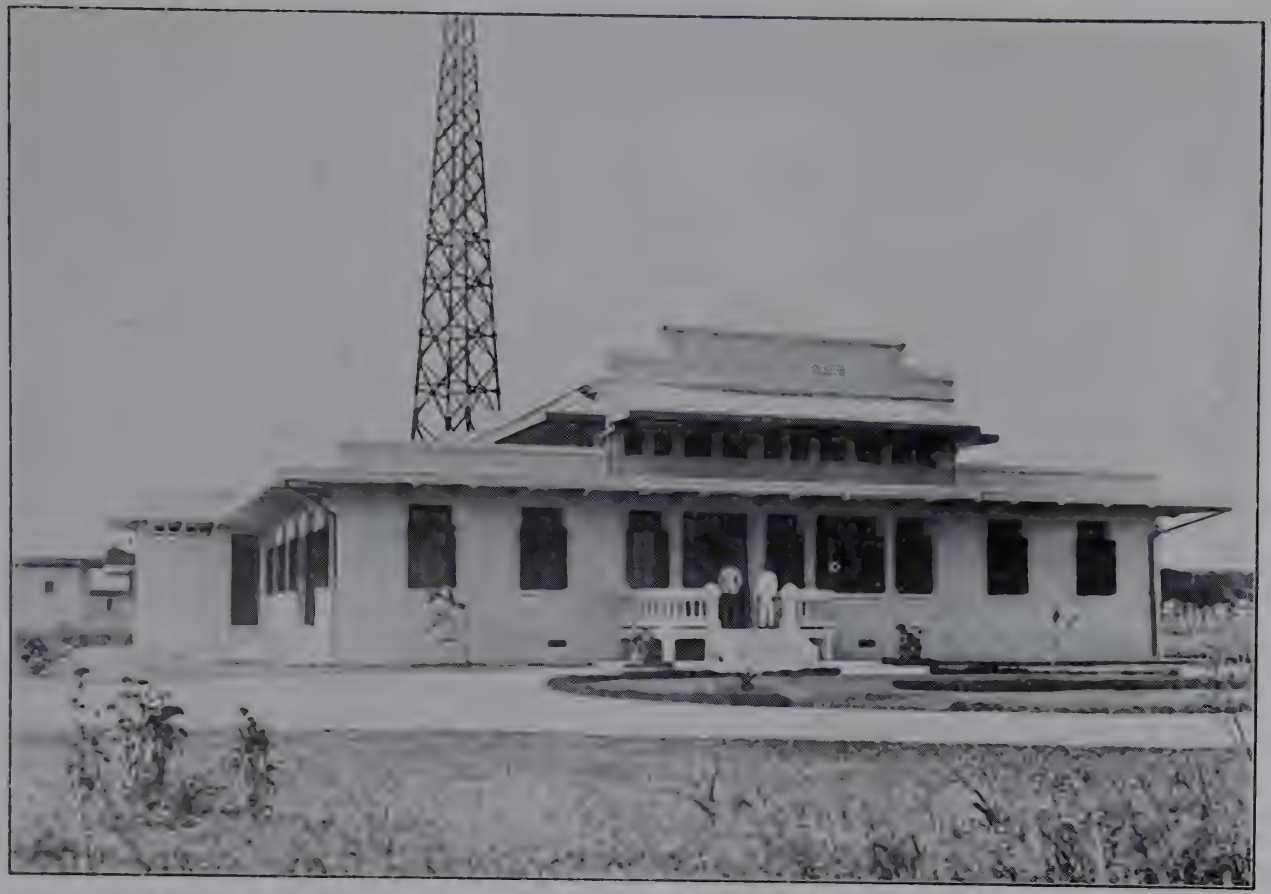
Local	Exchanges	Subscribers	Calls per year
Bangkok	2	2,621	12,497,965
Provinces	16	541	1,382,255
Total	18	3,162	13,880,220

Radio

Wireless telegraphy was first demonstrated in Siam in the year 1904, with two portable equipments set up at Kohsichang in the Gulf and at Bangkok, but the development of the science at that stage was not sufficiently advanced to justify the Post and Telegraph Department in establishing permanent stations in the country.

In 1907 the Ministry of War introduced field sets and detailed some of its army officers to study this important branch of Engineering. Early in the year 1914 the Ministry of Marine established two coast stations at Saladaeng (Bangkok) and Songkla, ultilizing the Telefunken spark system. The stations were for naval use only, but in 1919 they were opened also for general shipping service under arrangement between the Ministry of Marine and the Ministry of Communications, which controlled the Post and Telegraph Department.

Later, in 1920, the Ministry of Marine set up another small



New 20 K. W. Shortwave Transmitting Radio Station, Saladeng.

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station at the outer light ship at the Bar, and in 1924 the Post and Telegraph Department established another coast station at Koh Kham (near Kohsichang) for use of ships in Kohsichang Harbour.

Siam joined the International Wireless Convention in 1906 and enacted a Radio Telegraph Law in 1914, in compliance therewith and to regulate the use of wireless in the country. Up to then only coast stations were considered, but the progress of international communication was also being examined, and Siamese engineers were sent out to Europe to study modern developments.

Then, in the year 1927, with the reorganization of the Post and Telegraph Department, all the coast stations operated by the Navy were taken over by that Department and opened for full public service. Additional receiving apparatus was acquired and arrangements made to receive all the available foreign radio news for the newspapers. Plans were developed for direct communication with Europe and surrounding countries. This scheme provided for a group of transmitters at Saladaeng station and a group of receivers at Bangkok Noi, some eight kilometres distant from the transmitting stations, with a central control at the General Post Office, where actual transmission and reception would take place.

A contract for a 20 kilowatt shortwave and a 3 kilowatt longwave equipment was placed with Messrs. Telefunken, and a one kilowatt shortwave transmitter with the Radio Corporation of America to carry out the above scheme.

In 1929 the international radio service was opened to the public at lower rates than the prevailing cable rates and with greater speed and dependability than hitherto obtainable. Direct connection was established with Germany, England, France, Indo-China, Java, Philippine Islands and Hong Kong and through these countries to all other stations of the world.

The coast station at Saladaeng with the new 3 kilowatt longwave transmitter is capable of communication with ships in the China Sea and Indian Ocean by telegraph and with those in the Gulf of Siam by telephone in addition. The long power shortwave transmitter can communicate with any country in Asia,

while the high power shortwave station can operate with any other high power station of the world.

The progress of the traffic can be gauged by the following figures:

	1930	1929	1928
Words Sent	416,671	75,271	33,578
Words Received	1,078,968	849,291	21,063
Total ...	1,495,639	924,562	54,641

The Air Mail

For the purpose of improving the means of communication with the large and rich section in Northeast Siam, lying east of Pitsanulok and north of Korat, the Post and Telegraph Department entered into an arrangement with the Army for a weekly air mail service, which covers the area as far north as Udorn and Nong Khai, and as far east as Nakon Panom on the Indo-China border.

General

The Post and Telegraph Department, besides carrying on every phase of postal activities, also conducts the Postal Savings Banks, which work it took over from the Ministry of Finance this year. This service is being reorganized and expanded so as to extend its benefits to every part of the Kingdom.

In 1929 Siam signed the various agreements of the Universal Postal Congress in London, and the Department has taken steps to avail itself of the facilities resulting from its covenants with the other countries of the world.

The importance of radio broadcasting as a means of educating the public was realized early and experiments in this field have been carried on for several years. The Department expects to complete the installation of a modern short and long wave broadcasting station in the capital, towards the end of this year.

Postal Statistics

The statistical tables that follow reflect the steady expansion of the Postal Service year by year, the volume of the inland and foreign mail, and information as to postage and radio rates.

Arrival of the Air Mail at Udorn.

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COMPARATIVE POSTAL TRANSACTIONS.

		B. E. 2471 (1928–2929)	B. E. 2470 (1927–1928)	B. E. 2469 (1926–1927)	B. E. 2468 (1925–1926)	B. E. 2467 (1924–1925)
Receipts	Baht	2,217,780	2,294,072	2,095,588	2,302,390	2,184,205
Expenditure	Baht	2,055,811	2,293,290	1,663,638	1,878,605	1,796,325
Money Order, Internal, Issued	Baht	6,913,564	7,369,686	6,681,173	5,471,756	4,441,328
Money Order, Foreign, Issued	Baht	116,323	117,848	116,661	116,539	126,534
Money Order, Foreign, Paid	Baht	36,837	40,423	50,321	45,608	23,471
Internal Mail Posted	Pieces	9,141,705	8,153,659	7,012,187	6,164,778	7,004,091
Foreign Mail Posted	Pieces	1,574,365	1,388,821	1,406,210	730,526	318,291
Foreign Mail Received	Pieces	3,299,869	2,934,601	4,101,338	2,038,060	1,695,224
Parcel Post, Internal	Pieces	84,318	102,572	107,874	65,685	73,609
Parcel Post, Foreign, Forwarded	Pieces	8,723	10,366	14,053	7,124	6,318
Parcel Post, Foreign, Received	Pieces	34,879	39,112	61,301	44,083	35,100
Telegrams, Internal	Number	755,652	648,865	489,064	367,158	377,209
Telegrams, Foreign	Number	445,920	434,075	324,309	397,519	351,112
Undelivered Mail	Pieces	31,721	26,781	21,477	15,898	30,976
Radio Words—Sent		75,271	33,578	21,063	—	—
Radio Words—Received (Including Press)	Pieces	849,291	326,900	19,818	—	—
Telephones in Service		2,617	2,450	2,026	1,801	1,790
Personnel		1,668	1,448	1,382	1,346	1,544

REVENUE AND EXPENDITURE

SERVICE	Year 1929				Year 1928			
	Revenue		* Expenditure		Revenue		* Expenditure	
	Baht	Stg.	Baht	Stg.	Baht	Stg.	Baht	Stg.
Post and Telegraph	1,641,734	18	1,618,604	58	1,845,671	26	1,432,572	16
Telephone	533,166	59	304,283	28	436,103	18	412,256	52
Radio	42,879	33	132,923	47	12,297	82	448,462	16
Total	2,217,780	10	2,055,811	33	2,294,072	26	2,293,290	84

* Expenditure includes capital investment, which now, however, has been segregated from the operating costs.

INLAND AND FOREIGN MAIL PIECES IN 1929

DESCRIPTION	INLAND	FOREIGN	
	Mailed	Mailed	Received
Registered articles	350,246	78,208	112,437
Prepaid letters	4,201,766	997,867	1,565,044
Surcharged letters, etc.	35,659	8,021	79,937
Postcards	1,381,549	93,964	96,629
Printed matter	2,682,017	364,364	1,356,394
Commercial and legal papers	495,885	13,624	35,828
Samples	6,825	14,053	45,897
Official free letters	10,599	4,238	7,521
Official free parcels and other articles	9,299	26	182
Total	9,173,845	1,574,365	3,299,869
Parcels	84,318	8,723	34,879

Postage Rates

	Local	Inland	Foreign
	Satang	Satang	Satang
Letters, for the first 20 gr.	5	10	15
,, for every additional 20 gr. or fraction	5	10	10
Post-Cards, single	2	3	10
,, with reply	..	..	20
Printed Paper, for every 50 gr. or fraction	2	2	3
Commercial Papers, do do	2	2	3
Minimum	5	10	15
Patterns and samples of merchandise, for every 50 gr. or fraction	2	2	3
Minimum	5	5	6
Registered Newspapers, for the first 100 gr.	2	2	..
for every additional 50 gr. or fraction	2	2	..
"Blind Literature," packets for every 500 gr. or fraction	..	..	3
Mixed Packets, for every 50 gr. or fractions	2	2	3

Radio Rates

Europe except Canary, Faroe and certain Greek Islands, Greenland, Spitzbergen and Iceland—Ordinary, Baht 1.10.

United States—Ordinary, Zone 1—via Europe, Baht 1.60; via Pacific, Baht 1.65.

Japan—Ordinary, Baht 1.25.

Hong Kong—Ordinary, Baht 0.75.

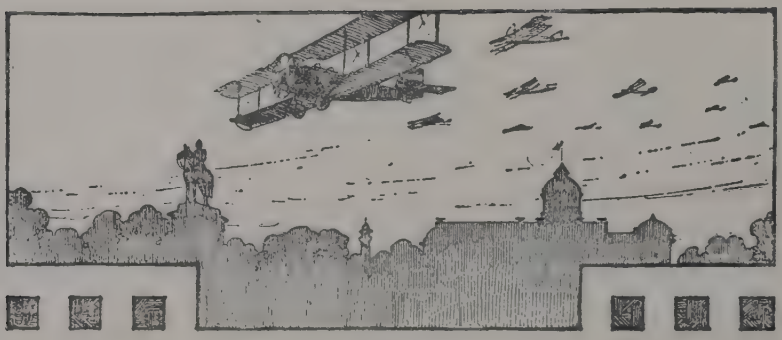
Netherland Indies—Ordinary, Baht 0.80.

Manila—Ordinary, Baht 0.80.

Shanghai—Ordinary, Baht 0.90.

China (Other Points)—Ordinary, Baht 1.15.

Deferred radiograms are half the ordinary rate; urgent radiograms triple the ordinary rate.



CHAPTER XXI

COMMERCIAL AVIATION

Aviation began in Siam, as in other countries, as a military activity, and, following the trend of aeronautics the world over, is entering upon an era of commercial flying.

The geographic position of the country and its physical characteristics give Siam a peculiar advantage in commercial air operation, both internal and international.

Large, productive regions in Siam isolated from the railways by extensive jungles, furnish a field for profitable inland air service. It was for the purpose of improving communication facilities between the railway line and the productive section north and east of Korat that Siam established its first commercial air line. This service, operated by army airplanes, began in June 1922, and has been in continuous operation since. The first route extended from Korat to Ubol on the Indo-China border, via Roi Et, a distance of 363 kilometres. In the following year a second route was opened between Korat and Nong Khai via Roi Et and Udorn, a distance of 431 kilometres. Both of these routes served a useful purpose and were well patronized, the operations over a period of seven years being as follows:

YEAR	Length of Routes Opened km.	Air Craft Kilo-metres Flown	Number of Persons Tran-sported	Number of Bags Tran-sported	Weight of Merchandise Transported
B. E.					Kg.
2465 (1922–23)	363	8,160	1*	1,705	9,417,490
2466 (1923–24)	794	45,764	43*	1,605	5,553,967
2467 (1924–25)	794	79,305	52*	2,725	7,215,489
2468 (1925–26)	794	76,330	65*	3,342	10,861,870
2469 (1926–27)	794	98,456	1,860	3,961	14,098,200
2470 (1927–28)	794	82,576	1,576	3,848	17,564,010
2471 (1928–29)	794	73,145	249	3,466	18,152,990

* Exclusive of free passengers.

In the past year a change was made in the routes, which illustrated the difference between commercial air operations in a well populated and high commercially developed region, and one which is yet to be developed. In Europe and America commercial aviation supplements the railway and steamship lines with a faster, though more expensive service, but in such undeveloped regions as are served by the Siamese air routes, commercial aviation precedes the railway, and retires before its advance, until there is sufficient commerce to justify the faster service by air. Thus in 1929, with the extension of the railway from Korat toward Ubol, it was found advisable to transfer the original air route, extending from Korat to Ubol, to new undeveloped territory, and service was opened from Korat via Roi Et to Nakon Panom, a more northerly point on the Indo-China frontier.

But it is as the safest, and most economical gateway from Europe and America to China, the Philippines, Dutch East Indies and Australia that Siam is assured its advantageous position in international aviation. The Government, sensing the importance of this situation, has already taken the initial steps to free the mountains and jungles of their danger to airmen, and make the airways through Siam the equal of the best in any land, through the establishment of proper ground facilities.

It is possible to fly from India to the Dutch East Indies and Australia by seaplane along the Burmese, Siamese and Malay

coasts, but it would be unsafe as well as costly, and it would not be possible to maintain schedules during the period of the monsoons that sweep in from the Indian Ocean.

It would be possible to fly from Europe to China by the Siberian route, but it would be a dangerous and unreliable operation during the winter months, and consideration of such a route is always based on a summer operation.

Against such possible air operations Siam offers an all the year round safe land route, almost a straight line east and west from Rangoon to Indo-China; another north and south route parallel from Pitsanulok to Malaya by a splendid railway system; over a vast stretch wholly free of typhoons.

Already the Dutch Air Line operates a fortnightly service from Holland to the Dutch East Indies via the Siamese gateway. The French will operate from France across Siam to Saigon during the present year, and the projected Imperial Airways to Australia has already reached Delhi, All these lines touch Rangoon, and then trend southward to their respective destinations.

This leaves a gap of some 2,000 kilometres between Rangoon and Hongkong to fill, in order to tie up by air the valuable China trade with the commercial centres of the Occident. To fill this gap the Siamese have organized the Aerial Transport Company of Siam, Ltd., which will operate a 1,400 kilometre route from Rangoon to Hanoi, there to connect with a seaplane operation to Hongkong and Canton. This operation not only will bring Hongkong within 11 days from London, but will enable a person to travel around the world over regular, scheduled air services in 38 days or less, including the steamer transits across the Pacific and Atlantic Oceans.

AVIATION LINES
British Line, in operation
British Line, projected
Dutch Line, in operation
French Line (a)
Hong Kong Seaplane Line (a)
Siamese Line (a)
(a) In preparation
LONDON
AMSTERDAM
BERLIN
PARIS
VIENNA
MARSEILLES
ROME
CONSTANTINOPLE
NAPLES
ATHENS
ALEPPO
BAGDAD
BASRA
BUSHIRE
ALEXANDRIA
CAIRO
GAZA
BANDA ABBAS
DELHI
JASK
KARACHI
ALLAHABAD
CALCUTTA
HANOI
HONG KONG
RANGOON
BANGKOK

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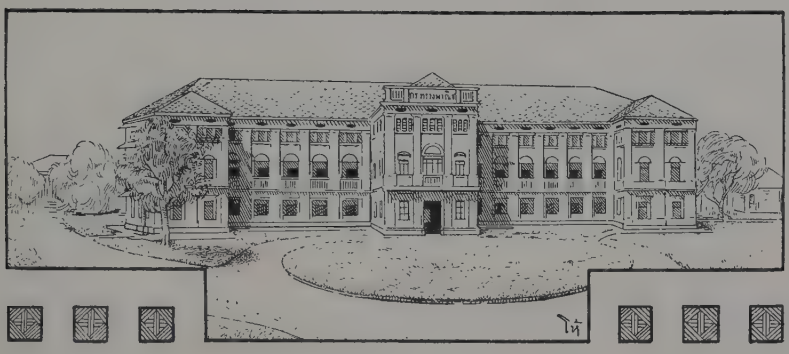

CHAPTER XXII

COMMERCIAL ADMINISTRATION

This chapter is concerned with the various activities of the Ministry of Commerce and Communications that are connected with commerce or commercial progapanda, in so far as they have not been dealt with in previous chapters. They are arranged, for the most part, under the headings of departments or sections.

Department of Commercial Registration

The Department of Commercial Registration comprises four Sections, viz. :—

(1) *A Bureau for the Registration of Partnerships and Companies*, whose duty is to register and control Partnerships and Limited Companies, and to see that they conform to the Laws in this matter. Companies and Partnerships which have been registered are classified as follows :—

Ordinary Partnerships	154
Limited Partnerships	63
Limited Companies	92

(2) *A Trade Marks Office*, whose duty is to receive applications for the registration of Trade Marks, for consideration when the Law on Trade Marks and Trade Names has been

promulgated. At present the total number of such applications amounts to 4,492.

(3) *The Central Bureau of Weights and Measures,* where prototypes of Weights and Measures of the Metric System are kept for verification purposes, has the duty of inspecting and verifying weighing and measuring instruments, and issuing certificates and licences to Manufacturers, Importers, Repairers and Sellers of such Instruments. The licences already issued are classified as follows:—

Importers of Weighing and Measuring Instruments				53
Sellers	„	„	„	97
Repairers	„	„	„	4
Manufacturers	„	„	„	3

The number of Weighing and Measuring Instruments and Weights which have been verified, and for which certificates have been issued is as follows:—

Weighing Instruments	1,657	of which	68	were found	incorrect
Weights	16,529	„	470	„	„
Weights for weighing precious stones	578	„	12	„	„
Measuring Instruments of Capacity for liquids	12,324	„	290	„	„
Measuring Instruments of Capacity for dry materials	1,431	„	154	„	„
Measuring Instruments of Length	107,301	„	898	„	„

At present the Law of Weights and Measures of the 17th December B. E. 2466 (1923) still gives the public the option to use either the standardised and legalised system of weights and measures or any other system.

(4) *The Office of the Comptroller of Insurance Companies,* whose duty is to control all Insurance undertakings which are authorised to carry on business in Siam. At present the following undertakings have been authorized to carry on business in Siam:—

Fire Insurance	47

Working Standards

Including measuring instruments of capacity for liquids, metal and metallic-linen tapes, brass weights and measuring instruments of capacity for dry materials.

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Life	„	2
Marine	„	15
Motor	„	3

Each Fire Insurance Company has to deposit with the Government a sum of 100,000 Baht, or security to that value. Each Life Insurance Company has to deposit in cash or security to the value of 50,000 Baht, or one-third of the premiums received in each year, whichever amount is higher.

Bureau of Commercial Information & Trade Enquiries

The activities of this Bureau consist of the following sections:—

Commercial Information.—For the convenience and reference of merchants, travelling agents and visitors to the Economic Museum, a complete list is kept of all firms—both wholesale and retail—together with their addresses, and telephone numbers. This section has also the duty of supplying information to all individuals, firms and manufacturers established in foreign countries desirous of trading with Siam.

Trade Enquiries.—For the promotion of trade, this section puts the merchants of the interior of Siam in touch with those of the Capital and the latter again in touch with firms abroad. It undertakes the collection of information respecting the fluctuations and the ruling prices of all commodities in the Siam market, and a list thereof is compiled daily and available for inspection to all interested in the trade of the country.

Padi Report.—A register is kept of padi landed in all Bangkok rice-mills showing quantity, quality, price and place of origin. Though this register is available for public inspection at any time during office hours, yet many firms prefer to have the information supplied them daily, so they subscribe to this Section, the fee being Baht 60 per annum.

Other Activities.—In addition to the above this Bureau has the charge of the record of Meteorological Observations, and the supply of data to many Government Offices and Newspapers. The instruments are open to public inspection day and night.

A Commercial Directory is published by this Bureau at cer-

tain intervals, at the price of Baht 5 per copy (see under 'Publications').

Notice of arrival of steamers at Paknam with mails on board is also posted at the gate of this Office.

Economic Enquiry Section

The duty of this branch of the Ministry of Commerce and Communications is to enquire into the economic conditions of the country, in order to supply the Administration with any information it may require for the purpose of development or improvement, and to compile economic statistics and monographs on the products of the country.

During the last few years the Section has been able to gather statistical data regarding the production, trade and industry of the most important products in each province; the rates of labour for rice cultivation, fisheries, mining and other industries; the rent of padi and garden land; the rates of interest on capital and the index numbers of the cost of living of the population. The economic resources have also been investigated and the results laid down in the form of reports or monographs, such as those on Sticklac, Silk, Pepper and Rice-mill Industry.

The Government Laboratory

The Government Laboratory was organised in 1919 to undertake and co-ordinate the chemical work of the country. A special building for the purpose was erected, and equipped to carry out the wide scope of work which fell within its programme. The object was to preclude the creation of a number of small laboratories, which, under the circumstances, could only be inefficient or unduly costly. The building includes three analytical laboratories and a technical branch, equipped with plant on a semi technical scale, for the investigation of raw natural products, the preparation of commercial samples, and the manufacture of drugs on the large scale.

As may be imagined, a large variety of analytical work has to be undertaken, and methods adapted to suit a variety of problems peculiar to the country. Full details of the work carried out will be found in the Reports of the laboratory which are issued

One of the Analytical Laboratories

The Technical Laboratory

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periodically.

A short sketch will first be given of the main analytical activities of a routine or semi-routine nature. The control of opium dross constitutes the largest branch of repetition work, over 20 morphine assays being made daily, of dross purchased by the Government, which is suspected of adulteration. The importation of skimmed milk is prohibited; necessitating the control of tinned milk in accordance with the standards under the Law. Toxicology is a branch of interest, including the analysis of suspected poisons and viscera, involving a knowledge of the poisonous plants occurring locally. Much progress is yet to be made in this subject in the tropics, satisfactory analytical methods not yet having been evolved for many of the glucosidal and other poisons which are readily available in the jungle, and are known to those with criminal intents. Police cases present a variety of interests, including the examination of bombs, forgeries, blood stains, counterfeit coins etc., when rapid analytical procedure has to be combined with a general knowledge of criminal practice and local possibilities as to materials and processes.

Analyses of harmful habit-forming drugs and illicit opium are numerous. The large buying Departments, such as the Royal State Railways, are important users, submitting a variety of imported materials. Coinage silver for the Mint is assayed, and numerous examinations are made for the Customs and Excise Department. Work is accepted from the Public on payment of fees, under this head coming damaged cargo in connection with insurance claims, exports, such as rice meal, minerals, etc.

Turning to more constructive branches, the preparation of Vitamin B extract, and drugs for the treatment of leprosy, are of interest from the point of view of tropical medicine. The Vitamin extract is prepared on a large scale from rice polishings, and the maximum output is taken for the treatment of beri-beri. *Hydnocarpus anthelminthica* occurs freely, the oil being expressed locally, and the ethyl esters prepared from it. A number of vegetable products of interest have been examined, sometimes in co-operation with research institutes abroad, where pharmacolo-

gical investigations are in progress of several Siamese medicinal plants. Such materials must be selected with care, as popular beliefs are apt to be unduly optimistic, and in some cases entirely undeserved. Mitragynine, from *Mitragyna speciosa* has been isolated, and its pharmacology is now being studied abroad. It is probable that the tropics can still supply new and valuable drugs, though their investigations are time consuming and costly. Products with commercial potentialities, such as essential oils etc., have been prepared on the technical scale, with a view to their exploitation. The Laboratory has been instrumental in aiding the establishment of a local industry producing Hydnocarpus oil, which is now exported to leper hospitals throughout the world.

The considerable programme of analytical and development work is continually being modified and expanded in keeping with the progress of the country.

Botanical Section and Economic Museum

The *Botanical Section* was started in 1920 with the object of carrying out a rough survey of the flora of Siam, particularly with regard to plants of economic value, or likely to be of economic value. As it is not at all easy to fortell what plants are likely to be of economic importance, this survey has practically resolved itself into an attempt to get as complete a record as possible, of at least the flowering plants of the country. Plants and their products, which are likely to be of economic importance are sent to the Government Laboratory for examination and report. In the past ten years the Section has built up a herbarium containing about 20,000 sheets. Through the kind offices of the Royal Botanical Gardens, Kew, in the first instance, the work of identifying this material was very kindly undertaken by Professor Craib, of Aberdeen, who has been working at the flora of Siam for the past twenty years.

In connection with the *Botanical Section* an *Economic Museum* was established and opened by His Majesty the King on December 17th 1926. The object of this museum is to illustrate as fully as possible the economic resources and industries of the

The Economic Museum

country. It contains a fairly representative collection of the economic products of the Kingdom, but it is hoped that it may be considerably expanded when more room is available.

Publications

The principal publication of the commercial side of the Ministry of Commerce and Communications is "*The Record*", which is published on behalf of the Board of Commercial Devolpment. The first number appeared in June 1921 and it has been issued quarterly ever since, in two editions, a Siamese and an English. This Journal contains abstracts of the Proceedings of the Board, current statistical information, reports and notes on commercial, economic and financial subjects, and various other matters connected with the development of the Country. Since the first number appeared the size, both of the Journal and of its circulation, has increased considerably.

In connection with '*The Record*' a '*Technical and Scientific Supplement*' is issued from time to time, as suitable subjects become available. This supplement is designed to publish articles of a more technical nature than those in 'The Record'. Articles have appeared in it on engineering, agricultural and botanical subjects.

The Ministry also issues a *Commercial Directory* for Siam, which is designed to supply details of the Foreign Trade and Commerce of Siam, and also of those firms established in Siam who export and import goods direct, for the information of traders abroad who may desire to enter into commercial relations with Siam.

Note on the Authorship of the Chapters in this Volume

As stated in the introductory note, this volume is partly based on a series of pamphlets issued in 1926. It is proposed to give here the authors of those pamphlets that have been used in this volume, to indicate roughly the way in which the original pamphlets have been treated, and to give the authors of the articles in their present form.

I. *Physical Features.* The pamphlet was written by W. M. Gilmore, Technical Expert, Royal Survey Department, and has been reprinted practically unchanged.

II. *Geology.* The pamphlet was compiled by A. Kerr, Director of the Botanical Section, Ministry of Commerce and Communications, and has been revised for the present chapter by the same author.

III. *Climate.* The pamphlet was written by H. Brändli, of the Royal Irrigation Department, Ministry of Lands and Agriculture. The present chapter is a revision by the same author.

IV. *Flora and Vegetation.* The pamphlet was by A. Kerr, who has revised it for the present chapter.

V. *Fauna.* The pamphlet on this subject and the present chapter were both written by several authors, as follows:—

Butterflies by E. J. Godfrey, late Organising Science Master, Ministry of Public Instruction; it has been reprinted practically unchanged.

Other Insects by W. R. S. Ladell, chief of the Bureau of Agricultural Science, Ministry of Lands and Agriculture, revised and enlarged by the same author.

The remainder of the *Fauna* was written by H. M. Smith, Adviser to the Department of Fisheries, Ministry of Lands and Agriculture, who has revised and extended it for the present chapter.

VI. *Ethnology.* The pamphlet was compiled by A. Kerr. The present chapter has been re-written by E. Seidenfaden, late of the Provincial Gendarmerie.

VII. *Mining.* The pamphlet was written by various officials of the Royal Department of Mines, Ministry of Lands and Agriculture, who have revised and largely re-written it for the present chapter.

VIII. *Forestry.* The pamphlet was by D. R. S. Bourke-Borrowes, late Adviser to the Royal Forest Department, Ministry of Lands and Agriculture. For the present chapter the statistics of the original pamphlet have been brought up to date by Phya Daruphan Pitaks, Chief Conservator of Forests, of the above Department.

IX. *Aquatic Resources.* The pamphlet was by H. M. Smith, who has revised and partly re-written it for the present chapter.

X. *Agricultural Science.* This chapter is by W. R. S. Ladell. It did not appear in pamphlet form.

XI. *Irrigation.* The pamphlet was by C. D. Gee, Consulting Engineer for Irrigation Works, Ministry of Lands and Agriculture. It has been re-written for the present chapter by the same author.

XII. *Rice Industry.* The pamphlet was by Phra Pramonda Panna, Editor of the "Record", Ministry of Commerce and Communications, who has revised it for this chapter.

XIII. *Other Crops.* This chapter is by W. R. S. Ladell. It did not appear in pamphlet form.

XIV. *Lac Cultivation.* The pamphlet was by Luang Prakit Sahakorn, Superintendent of the Economic Enquiry Section, Ministry of Commerce and Communications, who has re-written it for this chapter.

XV. *Minor Industries.* This is by A. Kerr. It was not in the pamphlet series.

XVI. *Co-operative Movement.* The pamphlet was written by Luang Dej Sahakorn. It has been revised by the same author for this chapter, and approved by the Registrar of Co-operative Societies.

XVII. *Foreign Trade and Commerce.* In the pamphlet on 'Resources', which was written by R. S. le May, Adviser to the Ministry of Commerce and Communications, there was a sub-section on Foreign Trade and Commerce, which has been revised and partly re-written for this chapter by A. Kerr.

XVIII. *Railways.* This chapter is by Phya Sarasastra Sirilakshmana, Commissioner General of the Royal State Railways, Ministry of Commerce and Communications. It did not appear in pamphlet form.

XIX. *Roads* This chapter is by Phra Sathien Thapanakitya, Chief Highway Engineer, Department of Ways, Ministry of Commerce and Communications It was not in the pamphlet series.

XX. *Post and Telegraphs.* The author of this chapter is Phya Prakit Kolasastra, Director General of Post and Telegraphs. It was not issued

in pamphlet form.

XXI. *Commercial Aviation.* This chapter has been written by O. Praeger, Adviser to the Post and Telegraph Department, Ministry of Commerce and Communications. It did not appear in pamphlet form.

XXII. *Commercial Administration.* This chapter, which was not in the pamphlet series, was written by the Heads of Services concerned, as follows :—

Department of Commercial Registration ...	by Phya Saraniti Prija
Bureau of Commercial Information ...	by Phra Siddhi Byakarana
Economic Enquiry Section	by Luang Prakit Sahakorn
Government Laboratory	by A. Marcan
Botanical Section and Economic Museum ...	by A. Kerr

The sketches heading the chapters are partly taken from those on the covers of the pamphlets, which were designed by E. Manfredi. New sketches, by Nai Ho Wanako, have been made for chapters II, III, IV, V, VI, X, XIII, XV, XVIII, XIX, XX and XXII.

The Index has been prepared by O. Praeger.

Appendix

Calendar

The era in use in Siam is the *Phra Putta Sakarat*, commonly known as the Buddhist Era, or B. E., which dates from the attainment of Nirvana by Buddha in 543 B. C. In this era the year begins on the 1st of April; thus the 1st of April 1930 was the first day of B. E. 2473.

The official year is divided into twelve months, corresponding to those of the Gregorian Calendar, and the week into seven days. The old system of lunar months is, however, still used by the Buddhist Clergy and the country people.

Time

The actual time of Bangkok east of Greenwich is 6 hours 41 minutes and 57.3 seconds, but Standard, or Zone Time has now been adopted by Siam, which is 7 hours exactly.

The railways and some other Departments count the hours from 0 to 24, the day beginning at midnight; so, for instance, 4 p.m. is 16 o'clock.

Currency and Coinage

In the years 1908 and 1928 Acts were passed, placing the currency on a gold basis, and linking the Baht (Tical) with gold at the rate of one Baht for every 0.66567 gramme of fine gold.

The mean rate of exchange is now Baht 11/- to £1, or one Baht = 1s. 10d. The actual rate of exchange quoted by the Banks fluctuates a little according to the state of the market.

The unit coin is the Baht, or, as it is usually called by foreigners, the Tical, a silver coin, which, however, is now rarely seen in circulation. The other coins in use are:—

½ Baht (2 Salung)	...	Silver
¼ Baht (1 Salung)	...	Silver
10 Satangs ...	...	Nickel
5 Satangs ...	...	Nickel
1 Satang ...	...	Bronze

100 Satangs are the equivalent of 1 Baht.

Currency notes are issued by the Government for 1, 5, 10, 20, 100, and 1,000 Baht.

Weights and Measures

The chief weights in commercial use in Siam at the present time are the *picul*, equivalent to 133⅓ lbs. (Avoirdupois), or 60.47 kilogrammes; and the *catty*, of which 100 are equal to 1 picul. The Siamese terms for *picul* and *catty* are *hap* and *chang*, respectively.

The chief measure of capacity is the *kwien* or *coyan*, which is of variable capacity in different parts of the Kingdom. The Customs, for convenience, have interpreted the kwien, a measure of capacity, in terms of piculs, a measure of weight, for Siam's chief commodity, rice, as follows:—

1 kwien = 16 piculs of padi
= 22 piculs of cargo rice
= 23 piculs of white rice.

The chief measure of length is the *wa* (80 inches) and of area the *rai* (0.4 acres).

In 1923 the Metric System was adopted as the standardised and legalised system of Weights and Measures, but it still remains optional. Many Government Departments have adopted it for administrative purposes.

The following are some equivalents of common weights and measures:—

1 Picul (hap)	=	0.595 tons
	=	60.47 kilogrammes
	=	133⅓ lbs.
1 Standard Picul	=	60 kilogrammes
1 Ton (Ordinary)	=	16.8 piculs
1 Rai	=	0.4 acres = 0.16 hectares (New System)
1 Wa	=	80 inches = 203.2 centimetres
1 Standard Wa	=	2 metres
1 Sen	=	40 metres (New System)

Siamese Place Names and their Transliteration

There is at present no standardized system for romanizing the Siamese language, though many systems have been proposed. Scholars favour a system which will indicate every letter and diacritical mark used in the Siamese, while the ordinary man would like a system giving some idea of the pronunciation of the word, a by no means easy task. As an example of one method of transliteration may be mentioned a street sign-board in Bangkok, which has the word 'Drabya' on it; the

pronunciation of this word is, as nearly as possible, that of the English word 'sup'. One system of transliteration is explained on the map at the beginning of this volume. It must be remembered that where 'th' and 'ph' are used in Siamese names, they are never to be pronounced as 'th' in 'the' or 'ph' in 'phenomenon'.

A simple method is to disregard the tonal inflexions and varieties of aspiration, giving the consonants their English value and the vowels the pronunciation as in Latin languages.

The same place is sometimes known by two or more names, and place names have been frequently changed. The following are some well known instances of places with two or more names, including recent changes of name, together with some of the more usual variants of spelling. In each case the first word given is spelt according to the simple method indicated above. Names which are only of historical interest are not included.

Aran Pratēt = Aranya Pradhesa.

Ayutayā = Ayuthia = Ayudhya; commonly known as Krung Kao.

Bangkok is often known as Krungtēp = Krungdeb (the capital).

Bāngnarā is officially known as Narātiwāt = Naradhivas.

Chachôngsao = Chaxoengsao; usually known as Petriu = Petrieu.

Chantaburī = Chandaburi = Chandapuri; often called Chantabūn = Chantaboon, and locally Mûang Chan.

Chonburī = Jolpuri; commonly called Bāngplāsoi.

Chumpawn = Chumpon = Jumbara.

Kānburī = Kanchanaburi = Kanyachanapuri; locally known as Mûang Kān.

Kaw = Koh = Ko, the word for 'island'.

Kōrāt is the name in common use for the official Nakawn Rāchasimā = Nakawn Rajasima = Nagara Rajsima.

Krabī, often called by foreigners Gherbi, Gerbi or Ghirbi.

Krāt, is officially called Trāt.

Lampāng is locally known as Lakawn = Lakon (city)

Lopburī = Lobpuri.

Mênam = Meh Nam = Maenam, the word for river; equivalents are 'Mê' and 'Nam' used separately.

Nakawn = Nakon = Nakorn = Nagara; often called 'Lakawn'. It is the word for 'city'. A nearly equivalent word

used in N. Siam is 'Wieng' = Vieng.

Nakawn Chaisī = Nakon Chaisri = Nagara Jayasri. The capital of this Circle is at Nakawn Patom.

Nakawn Sawan = Nagara Svarga; locally known as Pāknampō.

Nakawn Sītamarāt = Nagara Sridharmaraj; locally known as Lakawn.

Pāknam (the town) is the common name for the official Samutprākān = Samudprakar.

Patalung = Badalung; locally called Mûang Lung, or Sīyêk.

Petchaburī = Petburi = Bejrapuri; locally known as Mûang Pet.

Pitsanulōk = Bisnulok.

Prachūap = Prachuab Kīrīkan = Prachuab Girikhandh; often known as Kaw Lak.

Prê = Phre = Prae = Phrae = Brae.

Pūket = Bhuket; called locally Tongkā; sometimes appearing on maps as Junk Ceylon or Salang.

Rāchaburī = Rajaburi = Rajburi = Rajpuri = Ratburi; often called by local people Ratpli.

Rahêng = Rahaeng, also known as Mûang Tāk.

Sawankalōk = Savargalok.

Songklā = Songkhla; commonly known to foreigners as Singora.

Surāt = Surashtra Dhani. This name was given to the capital of the Province of the same name, but the capital is now at Bandawn = Bandon, which consequently, is sometimes given the name of Surat.

Tāchīn is the common name for the town officially known as Samut Sakawn = Samudsagara.

Takūapā is usually known to foreigners as Kopah.

Trang is locally known as Tap Tieng.

Udawn = Udon = Udara; locally known as Māk Kêng.

Ubon = Ubol = Ubon Rāchatānī = Ubol Rajdhani.

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